DEVELOPMENT AND APPLICATION OF A DECISION AID FOR TACTICAL CONTROL OF BATTLEFIELD OPERATIONS: A PRELIMINARY EVALUATION OF A DECISION SUPPORT COMPLEX IN SIMTOS

by

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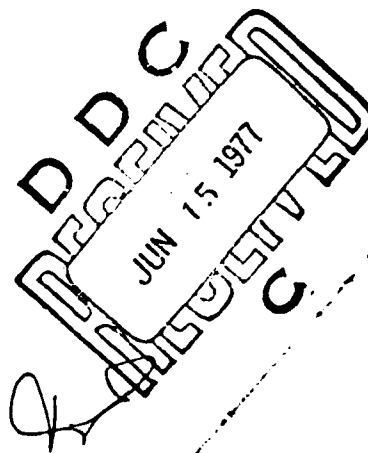2700 Ridgway Parkway,
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)
A review of the decision aiding literature has shown that a multitude of decision aids is needed to impact on an ultimate decision. A decision support structure was designed for use in a simulated tactical operations system (SIMTOS). The present research provided a preliminary evaluation of the decision support complex.

Ten participants were divided into two groups. One group used the decision aid throughout the simulated defensive scenario while the other group did not.

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20. Both groups participated in the same G3 planning and combat activities.

The aided group (i.e., the group using the decision complex) used more of the available resources than the unaided group. Although there was no significant difference between the two groups in terms of distance surrendered, or friendly and enemy force attrition, the trend favored the aided group.

The general results show that the concept of a decision support complex is a sound one. ARI is continuing to utilize the decision support complex in further studies of tactical decision making.

This is the third volume in a series of three on "The Development and Application of a Decision Aid for Tactical Control of Battlefield Operations" comprising the final report under Contract DAHC 19-73-C-0069 for the Army Research Instutute for the Behavioral and Social Sciences (ARI). Volume 1, "A Conceptual Structure for Decision Support in Tactical Operations Systems," is printed separately as ARI Technical Report TR-77-A2. Volume 2, "Decision Style Measurement and Decision Support Software Specifications," is a computer printout available on request from ARI. The series received the 1975 award from the American Psychological Association's Division of Military Psychology for outstanding scientific and professional contributions to military psychology.

The entire project is part of a continuing ARI program on simulated tactical operations systems (SIMTOS).

A PRELIMINARY EVALUATION OF A DECISION SUPPORT COMPLEX IN SIMTOS

BRIEF

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Requirement:

    To evaluate a decision support complex designed to help a G3 officer in acquiring information and making decisions within the simulated tactical operations system (SIMTOS) environment.

Procedure:

    Ten experienced tactical decision makers were used in this investigation. Participants acted as G3s in a SIMTOS defensive scenario. Typical planning and combat activities were included. Five participants used the decision support complex and five did not.

Findings:

    The aided group used significantly more of the available resources than did the unaided group. In terms of friendly and enemy force attrition as well as distance surrendered from the forward edge of battle, the aided group showed a trend toward superior tactical performance. There was, however, no significant difference between the two groups for these variables.

Utilization of Findings:

    Introduction of automated equipment into a decision system does not necessarily produce quicker or better decisions. The man-computer interface is critical to an information processing cycle in which data proliferate.

    Even though the present research on the decision support complex was preliminary and the number of participants small, the trend indicated that the concept of a decision support complex is sound.

    Further research in this area with subsequent implementation in an automated tactical operations center will contribute to an efficient military decision system. In this regard, ARI is continuing to utilize the decision support complex concept in further studies of tactical decision making.

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ABSTRACT

Volume 3

A Preliminary Evaluation

of a

Decision Support Complex in SIMTOS

A preliminary evaluation of an "estimate of the situation" aid and a "resource
allocation" aid in SIMTOS was conducted. Two groups were compared. One group
(the aided) received the "estimate of the situation" in both the planning
and combat sessions. The other group (the unaided) did not receive the esti-
mate aids. The "resource allocation" aid was available to both groups during
combat. Descriptive techniques were used to analyze the data from the small
sample (N = 10). The estimate aid was not used during planning due to its
failure to meet the requirements of a successful man/computer dialog. There-
fore, little difference was found between the aided and the unaided groups
during planning. For combat, the estimate aid was most effective early in the
task because it enabled the aided group to utilize their resources more effi-
ciently and monitor the course of play more efficiently. The "resource alloc-
ation" aid enabled both groups to achieve some success during the combat
play.

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DEVELOPMENT AND APPLICATION OF A DECISION AID

FOR

TACTICAL CONTROL OF BATTLEFIELD OPERATIONS

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DEVELOPMENT AND APPLICATION OF A DECISION AID FOR TACTICAL CONTROL OF
BATTLEFIELD OPERATIONS

Section 1   Introduction

3.1.1   Volume 1 Overview

. The initial volume of this report outlined a conceptual structure for
decision support in tactical information processing systems. The con-
ceptual structure was based on five variables: decision style, decision
situation, information, mode of presentation and human/computer dialog.
Each of these five variables serves both as an area of scientific in-
vestigation and a set of system specifications for decision support
systems. In Volume 1 the variables were treated as both. The concep-
tual structure served as the organizing entity by which the decision
aiding literature was reviewed and several "aiding themes" identified.
These variables also helped generate specific criteria or specifications
for decision support systems.

3.1.2   Volume 2 Overview

In Volume 2 the process by which the "aiding themes" were adapted to
the SIMTOS context was documented. The underlying generalization which

appeared throughout the work was the concept of the decision support system.

Two tasks were key to this integration phase of the research program. The first was the development of a technique to measure decision style to determine the type of the estimate aid in a manner consistent with the overall SIMTOS context. The second task involved the development of an integration technique for the decision support complex (as re-flected in software specifications) which resulted in changes to the existing SIMTOS software. The integration technique was also required to introduce the decision support complex into SIMTOS in a manner con-sistent with the requirements of meaningful human/computer dialog.

3.1.3   Volume 3 Organization

This volume details a preliminary evaluation of the effectiveness of a decision support complex in the SIMTOS environment. Section 2 con-tains a statement of the problem as well as the rationale for the ap-proach to the development of the decision support complex. The specific form of the decision support complex in SIMTOS and the methodology for its evaluation are also detailed in Section 2. Section 3 details the experimental methodology and procedure. Section 4 describes the results of the data analysis. A discussion of these results is contained in

3.1.3 Volume 3 Organization

Section 5, along with conclusions concerning the refinement and extension of the decision support complex.

Section 2   Evaluation Background

3.2.1   Developmencal Setting

The Army Research Institute (ARI) is investigating decision making be-
havior with the ultimate goal of improving the design of tactical com-
mand and control systems. The Army Research Institute's vehicle for
command and control research is SIMTOS (Simulated Tactical Operations
System). SIMTOS consists of an automated data base which can be ac-
cessed by the user to obtain information normally available from an
Army division staff.[1]

This report describes a research effort to evaluate a decision support
complex that will assist a G-3 officer in his information acquisition
and decision making activities within the SIMTOS environment.

3.2.2   Rationale for the Development of the Decision Support Complex

Much has been written concerning the nature and form of human decision
making, particularly in terms of a tactical environment. However, if a

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[1] See Krumm, Rowe, Torpey, and Ringel (1970) for a detailed discussion
of the genesis and implementation of this system.

3.2.2 Rationale for the Development of the Decision Support Complex   5.

single generalization can be made about this literature, it is that

the decision making process is not fully understood (Mack, 1971; Okrina,

1970). Further, what is understood has been gathered in studies more

elementary than the operational tactical scenario (Freedy, Weisbrod,

May, Schwartz, and Wettman, 1973). The lesson to be gleaned from the

technical literature is that any attempt to "aid" the decision maker

in realistic tactical environments cannot be totally dependent upon

existing models of human decision making. The present empirical study

of tactical decision making is generally model independent since ob-

servations of decision making are done "in vivo"--as they occur during

the course of an actual tactical problem as with the SIMTOS defensive

scenario.

Two major methodologies have emerged to aid the tactical decision making

process. One is mathematically based; the other situationally based.

In the mathematically based methodology, decision aiding is defined as

the allocation of decision functions between man and machine (computer)

in a way which optimizes their respective strengths (Freedy, Weisbrod,

May, Schwartz, and Wettman, 1973). The key to this methodology is to

assist the decision maker in optimizing his performance relative to

some external criterion. While the application of mathematically based

decision aiding techniques has led to much research, the contribution

of these techniques to tactical operations systems is unclear. These

3.2.2 Rationale for the Development of the Decision Support Complex   6.

procedures suffer from problems relating to the structuring of hypotheses, estimation of priors, untangling of source reliability, and robustness (Schum, Southard, and Wombolt, 1969).

If decision making is defined as a process by which the tactical officer organizes and interprets the information in his environment, another situationally based decision aiding methodology becomes apparent. This approach considers decision making and decision aiding in specific contexts, such as tactical scenarios. In this case, decision making is not defined as a mathematical function, but as the actual procedures used by decision makers. These two methodologies should not, however, conflict with each other but work in concert to provide techniques for decision aiding in human/computer systems.

A crucial task of decision aiding in an automated tactical information system is to provide an effective interface between the tactical decision maker and his computer system. In a complex system, such as SIMTOS, there is no situation wherein, if the decision making process were aided, it would provide a total, efficient interface. Therefore, a number of decision aiding techniques of mixed methodologies directed at different levels of the decision making process and system operation are required. This complex of decision aids is called a _decision support system_ (Meador and Ness, 1973; Morton, 1973).

A taxonomy of the decision aids within the domain of the situational methodology is depicted in Figure 3-1. Shown are decision aiding techniques that are adaptive (responsive to differences in decision style) and normative (designed to fit some general user--the "average" person). Within these techniques, four types of decision aids can be identified: organizational, performance, task specific, and process aids.[2] Organizational aids assist the decision maker in structuring his information into a systematic form (e.g., Kepner and Tregoe, 1965). In contrast, performance oriented decision aids assist the decision maker in using information in an optimal manner so that the decisions will be of better quality, considered in terms of some objective performance criterion (e.g., Brewin's 1964). A task specific decision aid focuses upon particularly complex or difficult task components, helping the decision maker cope with that aspect of his activities. Finally, process oriented aids are designed to help the tactician with his cognitive information processing activities, as these are presumed constant regardless of task specifics.

Using this structure as a guide, the decision aiding literature was reviewed. Seventeen aiding concepts were identified as potentially

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[2] The rationale for this decision aiding taxonomy has been extensively discussed in Volume 1, Section 1.2.3 of this report.

3.2.2 Rationale for the Development of the Decision Support Complex   8.

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         │  SITUATIONAL  METHODOLOGIES     │
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         ┌─────────────────────────────────┐
         │         TECHNIQUES              │
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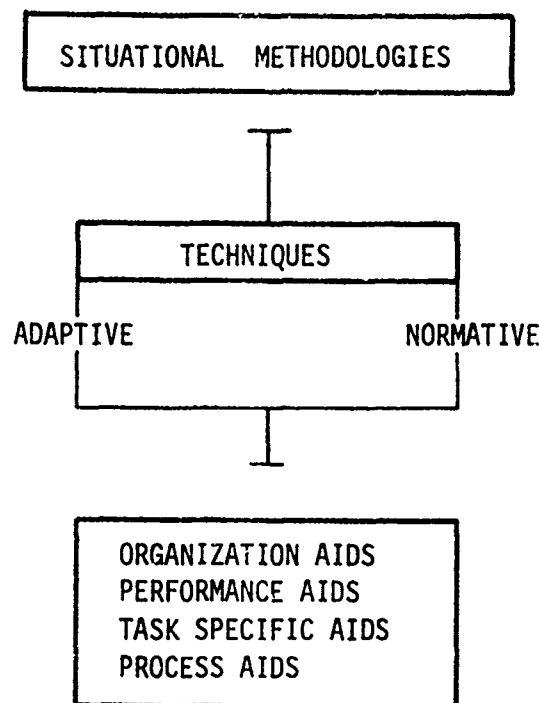
Figure 3-1.   Taxonomy of Decision Aids
              Within Situational Methodologies

relevant for the SIMTOS decision support complex.[3]   Three recurrent

aiding themes were isolated.   They are:

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[3] These 17 aiding concepts were believed to be exemplary of the liter-
ature in accordance with the types of aids listed above. A detailed
discussion of this is contained in Volume 1, Section 1.2.4 of this
report.

- Estimate of the situation aiding
- Resource allocation aiding
- Contingency planning aiding

Estimate of the situation aiding provides the decision maker with the relevant core information necessary to structure and interpret the problems in a decision situation. Since information requirements seem to be highly individualistic, "estimate" aids might be adaptive in nature. Resource allocation aiding provides the decision maker with the information and communicative authority to disperse resources in some systematic and optimal manner for a particular task or tasks. Contingency planning aiding provides the decision maker with the capability to play "what if" and to thereby study the consequences of alternative actions.

The decision support complex evaluated in this study reflects the first two of these themes. To implement the complex in SIMTOS, the specifications were adapted to the specifics of the system and its operating environment. The aids and their implementation are discussed briefly in the following section.[4]

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[4] The details of the implementation of the complex into SIMTOS are contained in Volume 2 of this report.

The Task

The scenario for this study consisted of a tactical defensive exercise for an operations officer (G-3) at the division level. The exercise was divided into two discrete sessions--planning and combat.

The planning session required the G-3 to construct plans for the 20th Mechanized Division to defend a sector of the Hof Gap in Germany. While the general situation was described in the Operations Orders, specific details on personnel, intelligence and other variables were contained in the _static_ SIMTOS data base. This data base consisted of ten categories of information, normally available to the entire staff of an Army division. Each of these ten catagories was repeatedly subdivided into more detailed levels of information, yielding a structure that goes from very general to very detailed information (see Appendix A, Exhibit 4).

For the combat session, the task was to execute a defense against an invading army in the same sector of the Hof Gap again acting as the G-3. During combat the data base was _dynamic_ in that it changed as a function of events (e.g., the incorporation of inputs from the G-3 and the pre-programmed directives concerning the enemy forces).

The Support System - Planning

The decision support system implemented into SIMTOS for this preliminary evaluation consisted, as indicated previously, of the concepts of situation estimate and resource allocation aiding. The G-3's task in planning was to assimilate the key information contained in the data base as a recommended course of action, concept of maneuver, and mission statements for the 20th Mech Division.

Based upon information requirements for performance of the G-3 officer's task, as specified in the Staff Officers Field Manual (FM101-5), an estimate of the situation aid was tailored to the SIMTOS planning session. Earlier studies of G-3 information requirements (Strub, 1971) provided guidance to information detail vis-a-vis SIMTOS.

The estimate aid consisted of selected information frames which could be directly accessed without using the general index to the data base. These frames were hypothesized to contain key pieces of information regarding the situation and thus provided the G-3 with an overview or "estimate" of what was contained in the data base. The G-3 had the option to continue in the data base from the point at which a file frame was located. Therefore, the aid also served as an index to the data base.

Large individual differences exist in the information seeking, information processing, and action selection behaviors of tactical decision makers. The estimate of the situation aid was therefore made adaptive by varying it to match four possible types of decision styles determined by the Decision Style Measurement Instrument (DSMI).[5]

The Support System - Combat

During a combat phase, much of a G-3's activities consist of monitoring and adjusting the defensive operational plans. In SIMTOS, this role takes the form of sensing the changing situation through changes in the data base. The SIMTOS system provides a method for keeping track of these changes through Standing Requests for Information (SRIs). If an SRI is set up on a piece of information, the G-3 is notified if any change occurs in that piece of information. For example, if an SRI is established on a unit location and subsequently that unit location changes, the system user is notified. Thus, the purpose of the SRI is to aid in the detection of key changes in the combat environment.

An estimate of the situation aid was again structured via the SRI function for incorporation into the SIMTOS combat session. A pre-selected

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[5] A short discussion of the instrument and G-3 assignment to groups is given in the next section. The full instrument and its derivation is contained in Volume 2 of this report.

SRI list was developed for the G-3. This list contained pieces of
information which highlighted the differences between the planning and
combat environments. The list also contained intelligence information
in the form of unit spot reports. Although it would have been desirable
to tailor this aid to the individual G-3, time and resources precluded
this. The developed list was therefore standardized and was, hence, a
normative aid form.

In addition, a resource allocation aid was developed for the SIMTOS com-
bat session. The aiding concept optimized weapon usage by allowing the
G-3 to select the weapon(s) to be used against a specific target. By
indicating the coordinates of a map location, the G-3 received a display
containing units, their associated weapon type, and standard volleys
or sorties that were within striking range of that location. The G-3
could then designate which, if any, of the units and how much of their
resources he wished to commit to firing at the specified location. This
aid was also normative and could be classified as a task aid according
to our taxonomy. Further, this aid was embedded in the system software.
Pilot sessions had shown that the combat task was almost unworkable due
to the complexities of the non-G-3 type tasks required and the speed
with which the problem developed. It was decided that without the re-
source allocation aid available to all G-3's, any differences in per-
formance due to the estimate aids would be overshadowed.

Independent Variables

To clarify, the aids discussed in the previous section were incorporate
into SIMTOS as follows:

- Planning Session

  1) adaptive

     - "estimate of situation"

- Combat Session:

  1) normative

     - "estimate of situation"

     - "resource allocation"

For the purpose of making a preliminary evaluation of the decision support
complex, two groups were established. One group (aided) had access to
the "estimate of the situation" aids and the other group (unaided) did
not. As indicated above, during the combat session, both groups could
access the resource allocation aid.

To determine the form of the aid for the planning session and for com-
parison purposes, each participant took the Decision Style Measurement
Instrument (DSMI) prior to the planning session. While, in theory, a
large number of decision styles exist, in practice it has been found
that groups of decision makers cluster around a very few dimensions of

style which uses three dimensions of information processing behavior
to classify eight types of decision styles (Figure 3-2). The DSMI was,
therefore, developed as a methodology of assessment of these eight
decision styles.[6]
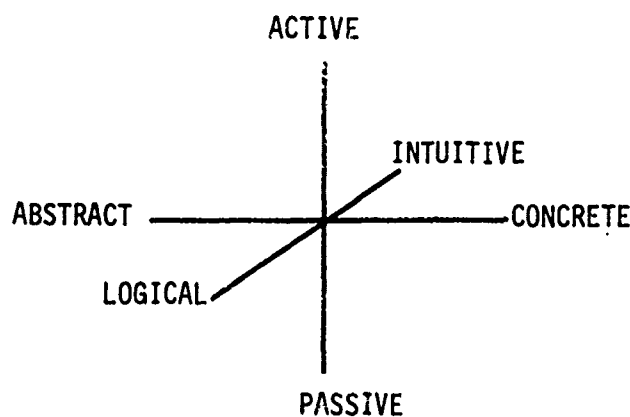
Figure 3-2. Dimensions of Decision Style

The forms of the estimate of the situation aid consisted of four lists
of frames from the planning data base. These corresponded to two of
the three dimensions of decision style as follows:

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[6] A full treatment of the DSMI rationale is contained in Volume 1 of
this report.

3.2.4 Evaluation Methodology

- Abstract-Logical
- Abstract-Intuitive
- Concrete-Logical
- Concrete-Intuitive

The abstract-concrete distinction was accounted for by specific list content; the logical-intuitive distinction by order within list content.

Depending on his decision style as measured by the DSMI, an aided G-3 had available one of the above four lists during planning. The active-passive dimension was accounted for in the instructions for use of the estimates. The active G-3's were instructed only in the mechanics of accessing the estimate. The passive G-3's were instructed in the mechanics but were also instructed to access each of the frames contained in the list before starting the task. The rationale used was that the more passive users would require prompting to use the aid.

Dependent Variables

Two types of measures were used to evaluate performance on the tasks: tactical performance measures and information processing measures.

Each G-3, during planning, wrote out his plans for a defensive operation. The elements on which the G-3's were assessed were: assignment of maneuver units to echelon, concept of maneuver, and mission statements.

These plans were scored using a procedure derived from Command and General Staff College norms by Bunker-Ramo (1973). For planning, the tactical performance measure was, thus, the scores on these written plans.

Adaptations of five measures "determined to be of significant importance in assessing combat performance during defensive operations" (Bunker-Ramo, 1973) were used for evaluation of tactical combat performance. They were:

- friendly force attrition

- enemy force attrition

- distance surrendered

- friendly force weapon expenditure

- friendly force air strikes expended

The information processing measures were used for evaluating system usage. The aid was linked to the behaviors reflected in these measures. For the planning phase, the following measures were used:

- sources sought

- action ratio

- error ratio

- redundancy ratio

- information acquisition efficiency

- aid usage

For combat, all of the above information processing measures were used plus the following measures specific to combat:

- resource allocation
    - usage efficiency
    - firing time

- SRI usage

- estimate aid usage

A complete discussion of both the terminal performance measures and the information processing measures and their derivation from the data is contained in the results section of this report. (See table – Appendix C.)

Hypotheses

In accordance with the variables discussed in the preceding sections, the following specific hypotheses were generated:

1. The aided group would score higher on the tactical performance measure for the planning session than the unaided group.

2. The aided group would use the system more efficiently according to the information processing measures than the unaided group during planning.

3. The aided group would score higher on the tactical performancce measures for the combat session than the unaided group.

4. The aided group would use the system more efficiently according to the information processing measures than the unaided group during the combat session.

5. A high correlation would exist between system usage efficiency and the tactical performance measures.

Section 3 Method

3.3.1 Consultants

The U. S. Army Military Personnel Division supplied the Army Research

Institute with a list of officers assigned to duty in the Washington,

D. C., area, who met the following minimum requirements:

- Education: Graduation from the Command and General Staff College
- Experience:

    1. Battalion commander or higher

        or

    2. S-3 of a brigade

        or

    3. G-3 of a division

        or

    4. Member of a division level staff

Ten officers from this list volunteered to act as participants in the

decision support complex evaluation.[7]

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[7] Background data on each of the consultants is summarized on page 42
of the Results section.

3.3.2 Experimental System

The Army Research Institute's SIMTOS Laboratory was used to conduct the
evaluation. The equipment and software comprising SIMTOS were set up
and operated as previously described (Bunker-Ramo, 1973) except as noted
below.[8]

Two participant work stations were set up: one for the aided and one
for the unaided group. Each station contained a CDC-211 CRT display, an
IBM lineprinter, a work table, a 24-hour clock set to run three times
faster than real time, a 25000:1 scale tactical map of the Hof Gap area,
and unit identification stickers for all of the friendly and enemy forces.
The aided work station had an additional CDC-211 display to present the
estimate aid. A separate experimenter station contained a CDC-211 CRT
from which activities at the work station could be monitored and controlled
remotely.

3.3.3 Procedure

The G-3's participated at the rate of one per day for approximately
nine hours. The scheduled procedure for the task is depicted in Table 3-1.

---

[8] The hardware and software modifications pursuant to the decision
support complex are discussed in detail in Volume 2 of this report.

3.3.3 Procedure

21.

Table 3-1. Evaluation Participation Schedule

TASKS \ HOURS	1	2	3	4	5	6	7	8	9
Introduction	▬								
DSMI Interview	▬								
Planning									
Instructions		▬							
Phase 1		▬							
Phase 2			▬						
Break				▬					
Combat									
Instructions					▬				
Static Hold						▬			
Dynamic Free Play							▬▬		
Debrief								▬	

Before beginning the planning session, the G-3's were taken to a work

station and given the following introduction and instructions for their

participation in the Decision Style Measurement Instrument (DSMI)

interview:

> "The Army Research Institute, an activity of the Army Chief
> of Research and Development, is studying decision making be-
> havior with the ultimate goal of improving the design of
> tactical command and control systems. They are concerned
> with military information processing and simulation, problem
> solving, and decision making behavior. SIMTOS (Simulated
> Tactical Operations System) was designed by the Army Research
> Institute to be used as a tool for conducting their research.
> SIMTOS consists of an automated data base which must be
> accessed by the particular user (in your case, a G-3 officer)
> to obtain information normally available from the division
> staff officers.
>
> The Life Sciences Group of Honeywell, Inc. is developing and
> evaluating a decision aiding complex to assist the G-3 offi-
> cer in his information acquisition and decision making acti-
> vities within this SIMTOS environment. The overall objective
> of this research is to develop principles of decision-aiding
> applicable to military tactical command and control systems
> in general.
>
> An integral part of this research is concerned with a command-
> er's information processing characteristics or "decision
> style." Therefore, we will conduct an interview consisting
> of a set of scenarios illustrating different decision situa-
> tions. You will be given sets of alternatives between which
> you must choose, based on your perception of the role de-
> picted in the scenario. These alternatives are not meant to
> be mutually exclusive; however, you must select the one
> closest to your own viewpoint. I want to emphasize that there
> are no right or wrong answers to these questions. Remember,
> answer as if you are in the role described."

The introduction, instructions, and the administration of the DSMI inter-
view required about one and one half hours. After the interview, the G-3
was given the following items to read:[9]

  ● Tactical Situation Summary (Exhibit 1)

  ● OPORD 63 (Exhibit 2)

  ● Planning Activities Overview (Exhibit 3)

The experimenter returned to his work station to score the DSMI and
set up the experimental environment according to the procedures
described below:

  ● Turn teletype off (switch "F" for aided, switch "M"
    for unaided away from "computer")

  ● CRT operation:

    1. "LINE SKIP" cursor to "INITIAL START"
    2. Type "X" and press "SEND"
    3. Press "SEND"
    4. Type "P" and press "SEND"
    5. Type "6"[10] and "LINE SKIP" to "LOGIN"
    6. Type "X" and "SLEW" to "SCENARIO (D or O)"
    7. Type "D" and "SLEW" to "SUBJECT NUMBER"
    8. Type three digit number identifying G-3 and press "SEND"
    9. Type "6" and "LINE SKIP" to "START PLANNING SESSION"
    10. Type "X" and press "SEND"
        (For unaided skip to G-3's recording message procedure)
    11. Type "6" and "LINE SKIP" to "CHANGE OPERATING ENVIRONMENT"
    12. Type "X" and "SEND"

_____

[9] All instructions and response sheets are identified with exhibit
   numbers and are contained in Appendix A.
[10] For unaided G-3's, substitute "5" for "6" in all cases.

13. "LINE SKIP" to LOAD SRI SET NUMBER (00-05)"

14. Type two digit file number according to measured decision style and "LINE SKIP" to "MODIFIED PLANNING SESSION (YES-NO)"

15. Type "YES" and "SEND"

● Procedure for recording messages:

1. Type "6" and "LINE SKIP" to "RECORD MESSAGE"
2. Type "X" and "SLEW" to the row of dots
3. Type message (max. 11 characters) and "SEND"

● Record the following messages:

1. "START PLAN"
2. Name of G-3
3. G-3 code number
4. Time of day
5. "STRT INSTRCT"

The experimenter then went to the G-3's work station and read the planning

instructions:

"To complete your planning activities, you will have access to an automated tactical data system (SIMTOS). This system provides the information currently available from the division staff.

The information contained in the data base is organized under the following major categories as contained on the general index frame on the CRT:

1. G-1 Personnel
2. G-2 Intelligence
3. G-3 Operations
4. G-4 Logistics
5. G-5 Civil Affairs
6. Fire Support Element
7. Chemical, Biological, Radiological
8. Engineer
9. Signal
10. Transportation

You can call up the desired tactical information using the
CRT, according to the procedure I will now demonstrate to
you."

The G-3 was given the data base chart (Exhibit 4) and instructed to:

- Start from the G-3 category and step all the way down to
  the platoon level using "number" alternatives.

- Use "B" option key to return to battalion level and explain
  that this is the operating level for today's problem.

- At the battalion level, access the "letter" options (re-
  member to tell him that it is possible at this level to
  jump to the next letter without moving up a level).

- Use "A" option to go to the GENERAL INDEX

Aided G-3's were given the following additional instructions:

"Displayed information on this adjacent CRT is to assist
you in your planning activities. These are data base frame
titles. To obtain information, you must access the frames
associated with these titles, according to a procedure I now
will demonstrate to you. The information contained on the
frames was selected and arranged in accordance with your
specific decision style. This information is designed to
be an overview of the situation and also an index to the
data base.

In the lower right hand corner of the data base CRT are
three options which pertain to the aided CRT and which will
be available to you at all times. The "U" option will move
the cursor up the list of frame titles and the "V" option
will move the cursor down. You thus can position the cursor
in front of any of the frame titles. If you wish to see
the frame with that title, simply use the "W" option. The
frame will appear on the data base CRT. You are now in the
data base at the location of this frame and have all the
displayed lower frame options available.

Due to CRT space limitations, the frame titles are contained
on two pages. If you move the cursor off the top or bottom
of the list, the other page of titles will be displayed."

3.3.3 Procedure

The work station contents were then explained including:

- Maps

- Wall displays (3:1 clock, unit stickers)

- Work table and contents (telephone, paper, grease pencils, etc.)

After the Planning Activities Overview (Exhibit 3) was reviewed, the experimenter set the 3:1 clock to 2100 and gave the G-3 the Commander's Guidance (Exhibit 5) and Instructions and Response Sheet 1 (Exhibit 6). The experimenter returned to his station and started Phase 1 by starting the 3:1 clock and inputting the following messages to the computer:

- "ENDINSTRUCT"
- Time
- "STRT PHASE 1"
- "CLOCK STRT"

When one hour's time had elapsed, the 3:1 clock was stopped, and the following messages were input to the computer by the experimenter:

- "END PHASE 1"
- "CLOCK STOP"
- Time

The experimenter then collected Response Sheet 1 from the G-3 and gave him the instructions and Response Sheet 2 (Exhibit 7) and the instructions and Response Sheet 3 (Exhibit 8). The experimenter returned to his work station, started the 3:1 clock and input the following messages to start Phase 2:

3.3.3 Procedure

- "STRT PHASE 2"
- "CLOCK START"
- Time

After one hour, the experimenter stopped the 3:1 clock and input the

end messages and instructions to the computer:

- "END PHASE 2"
- "CLOCK STOP"
- Time
- Type "6" and "LINE SKIP" to "LOG OUT"
- Type "X" and press "SEND"

Response Sheets 2 and 3 were then collected and the G-3 was instructed to

prepare an SRI list as follows:

"An SRI (Standing Request for Information) is set up to
notify you when changes in a particular piece of information
occur, such as the location of a unit. During combat, you
will have a maximum list of 30 SRIs. As specifically as
possible, for the next 15 minutes, please write down the
information you would like to have in such a list."

After 15 minutes, the G-3 was dismissed for an hour's lunch break.

When the G-3 returned, he was given the Combat Session Briefing (Ex-

hibit 9) and OPORD 37 (Exhibit 10). Meanwhile the experimenter set up

the combat operating environment as follows:

- CRT operation:

  1. "LINE SKIP" to "RESTART"
  2. Type "X" and press "SEND"
  3. Type "6" and "LINE SKIP" to "START PLANNING"
  4. Type "X" and press "SEND"
  5. Type "6" and "LINE SKIP" to "START COMBAT SESSION"
  6. Type "X" and "SEND"

7. Type "6" and "LINE SKIP" to "HOLD SESSION (H-HALT or R-RELEASE)
8. Type "H" and press "SEND"
9. Type "6" and "LINE SKIP" to "CHANGE OPERATING ENVIRONMENT"
10. Type "X" and "SEND"
11. "LINE SKIP" to "MINUTES BETWEEN UPDATES (01-20)" and type "10"
12. "LINE SKIP" to "MINUTES IN GAME TIME INTERVAL (15-60)" and
    type "30"
13. "LINE SKIP" to "UPDATES BETWEEN SUMMARY RECORDS (01-12)" and
    type "01"
    (For an unaided G-3, go to Step 16.)
14. "LINE SKIP" to "LOAD SRI SET NUMBER (00-05)" and type "05"
15. Press "SEND"
16. Send the following messages:
    ● "STRT COMBAT HOLD"
    ● "STRT INSTRUCT"
    ● Time

The experimenter then read the following instructions for combat to the

G-3:

"You will be using the keyboard and CRT during these phases
to do more than just access the data base. There are several
modes of operation:

1. You can use the General Index and get information from the
    data base just as you did earlier.

2. You can Establish SRIs and you will be notified if changes
    have occurred following the data base update every 10
    minutes.

3. You can use the Communications capability. This lets you
    access the SRI categories. It also lets you maneuver and
    call in air strikes, reorganize battalion or company units,
    lay on artillery fires, or modify unit missions.

4. Aided only: The CRT display used during planning will
    contain preestablished SRIs. After the commencement of
    combat, this display will indicate only those SRIs which
    have changed. You may access this information directly
    via the U, V, and W options used previously.

These operations are accomplished using the following pro-
cedures:

1. Establish SRI

You can have a maximum of 30 SRIs at any one time. To
establish an SRI, call up the General Index and enter
any of the sub-indexes until the category appears for
which you want to establish an SRI. On the bottom half
of the screen you will note that the SRI option appears.
Your procedure would then be:

    a. Enter an "S" (the code to establish an SRI).

    b. Depress the SEND key.

This will establish an SRI for the displayed category of
information. If changes occur, you will be notified by
message on your typewriter, and you can then access the
SRI list to determine the nature of the change. This
will continue until you cancel the SRI.

2. Monitor SRI

When you select the communications (X) option and depress
the SEND key, the communications frame will appear. This
frame allows you to monitor your active SRI titles and
retrieve these frames directly.

The SRI frame titles are arranged ten to a page. If you
want to see the first ten, enter the digit 1 and depress
the SEND key. To see the second ten, either return to
the communications frame and enter the digit 2 or enter
P2. To see the third ten, follow the same procedure.
To retrieve a frame, go to its page, enter the associated
digit and depress the SEND key. Your only available
options at this point are to return to the SRI page or
to the communications frame.

3. Delete SRI

To delete an SRI, go to the communications frame (X) and
find the page of your SRI list which contains the SRI
you wish to delete. Enter "D" and the digit of the SRI
to be deleted, and then press the SEND button. This

SRI will then be deleted. The SRIs which occupied posi-
tions below the deleted SRI will move up one position
to fill in the gap and thus open a position for another
SRI to be established at the end of the list.

4. Modify task organization

If you want to modify task organization, go to the com-
munications frame and choose either the 20th Mech Div
Organic Units (4) or the 20th Mech Div Support Units (5)
and step down the organization until you find the specific
unit you wish to add to (it must be at the operating level
or below).

You then enter the letter "U" and depress SEND. You add
subordinate units to the unit of interest by spacing the
cursor down to the first three dots using the "LINE SKIP"
key. Look up the three digit code on the code sheet
(Exhibit 11) of the unit to be added and enter it over
the three dots. If more units are to be added, "LINE SKIP"
to the next three dots and enter the unit code, etc. When
you have entered all unit codes, press the SEND key and
reorganization will take place.

5. Modify unit mission

If you want to modify the mission of a unit, go to the com-
munications frame and choose either the 20th Mech Div
Organic Units (4) or the 20th Mech Div Support Units and
step down the organization to the specific unit.

You then enter the letter "Z" and depress SEND. A frame
containing a list of the types of missions will then appear.
The current mission of the unit of interest will have the
unit's coordinates listed after it. To change the mission,
LINE SKIP the cursor down to the dot opposite the line
which says "change mission" and enter the number of the
new mission. Then LINE SKIP to the six dots, enter the
new coordinates, and press the SEND key. The new mission
and the new coordinates of the unit will then appear.

6. Resource allocation

In order to allocate air strikes and tactical fires,
find the coordinates of the unit or units you wish to
fire upon. Go to the Communications frame (X) and select
option "6". On the frame that appears, enter the six
digit coordinate of the location to be fired upon and
press SEND. You will then have displayed those friendly
units within range of firing on the target.

To assign a fire mission, enter the number opposite the
unit you wish to have fire and press SEND. The unit will
then fire its standard number of volleys (or sorties for
tactical air strikes). If you wish the unit to fire
more than its standard number of volleys, enter the
number opposite the unit you wish to fire and then the
multiplication facto. (i.e., entering the digit 2 would
double the volleys, entering the digit 3 would tripe the
volleys, etc.).

Remember, however, that once a unit has been assigned to
fire, it will be committed to do so until after the next
update.

An update is a short period of time (about 30 seconds) that the
computer uses to incorporate the inputs you have made and also
those directives which have been pre-planned for the opposing
forces. With the exception of the first one, the updates will
take place every ten minutes. During the update, a message of
the form "update # ____ in progress for station # ____" will
appear on your CRT and you will be locked out of the system for
the 30 seconds. At the end of that time, a message of the
form "update # ____ has ended for station # ____" will appear
on your CRT, and you again have control of the system.

In order to give you time to orient yourself to the combat pro-
cedures by reviewing your SRI list, setting up artillery fires
and air strikes, etc., we have extended the first update period
to 30 minutes, after which combat will start. Remember that
any inputs you make during this extended update will be used
for the first update.

You have available three overlays which you can put on the
map if and/or when you need them. They are:

- Key terrain and avenues of approach
- Blocking positions
- Maximum lines of penetration

Time is 0400. The first update will be at 0530 and combat will
run until 1130.

If you have any questions or if you want a break, please contact
me via the telephone.

After these instructions, the experimenter returned to his station to

input these messages and start the combat hold phase:

- Messages:

  1. "END INSTRUCT"
  2. Time
  3. "STRT COMBT HOLD"

- CRT operation:

  1. Type "6" and "LINE SKIP" to "START COMBAT SESSION"
  2. Type "X" and press "SEND"
  3. Type "6" and "LINE SKIP" to "HOLD SESSION"
  4. Type "H" and press "SEND"

After 30 minutes, the experimenter released combat and input the follow-

ing messages:

- CRT operation:

  1. Type "6" and "LINE SKIP" to "HOLD SESSION"
  2. Type "R" and press "SEND"

3.3.3 Procedure

- Message

    1. "COMBAT RELEASE"
    2. Time

The combat session ran for 12 updates. After the 12th update, the experimenter "logged out" the G-3 and input the end messages as follows:

- CRT operation:

    1. Type "6" and "LINE SKIP" to "LOG OUT"
    2. Type "X" and press "SEND"

- Messages:

    1. "COMBAT END"
    2. "CLOCK STOP"
    3. Time

The G-3 was asked to complete the Personnel Data Sheet (Exhibit 12). Following any questions the consultant may have had, the session was concluded.

3.3.4 Data Format

Two types of raw data were available from the evaluation; hand written responses and computer record printouts. The DSMI data was manually gathered by the experimenter. Response Sheets 1, 2 and 3 contained the written defensive plans generated by each G-3 during the planning session, supplemented by one overlay depicting the G-3's defensive plan. Other G-3 generated materials included the SRI list and the personnel data sheet.

All interactions involving the computer were recorded on magnetic tape
and provided on a computer output summary for each G-3's participation.
This summary, called a "track file," contained the following informa-
tion during planning:

- Subject number

- Time in seconds between each input to the system

- Number of the frame which appeared on the CRT scope
  (Aid frames were preceded by the word "Transfer.")

- Messages input by the experimenter

During combat, the track file contained all of the above data, plus a
summary of the following after each update:

- Units that fired weapons during the update, including
    1. unit numbers(s)
    2. X and Y coordinate position
    3. unit name
    4. weapon number
    5. number of volleys or sorties

- Event number

- Total force status, including
    1. unit number(s)
    2. X and Y coordinate position
    3. mission
    4. situation
    5. general attrition
    6. weapon attrition and/or expenditure

7. subordinate unit numbers

8. unit names

An example of a track file for planning is shown in Table 3-2 and an example for combat is si.own in Table 3-3.

Table 3-2. Track File Summary: Planning Data   36.

RECORD TYPE	SUBJ NO.	ORIG	TIME	FRAME OR MESSAGE	CP UNIT	X POS	Y POS	MIS	SIT	ATT GEN	ATT BL
1	103	1	6125	33							
1	103	1	6130	331							
1	103	1	6136	3311							
1	103	1	6156	331							
1	103	1	6161	3312							
1	103	1	6189	331							
1	103	1	6200	3313							
1	103	1	6245	331							
1	103	1	6251	3314							
1	103	1	6287	331							
1	103	1	6296	33							
1	103	1	6300	332							
1	103	1	6317	3325							
1	103	1	6364	332							
1	103	1	6370	33							
1	103	1	6375	331							
1	103	1	6381	3314							
1	103	1	6388	33141							
1	103	1	6444	3314							
1	103	1	6540								
5	103	1	6573	TRANSFER							
1	103	1	6573	2842							
5	103	1	6719	TRANSFER							
1	103	1	6719	035							
5	103	1	6771	TRANSFER							
1	103	1	6771	2522							
5	103	1	6882	TRANSFER							
1	103	1	6882	035							
5	103	1	6957	TRANSFER							
1	103	1	6957	28151							
5	103	1	6976	TRANSFER							
1	103	1	6976	2536							
5	103	1	6993	TRANSFER							
1	103	1	6993	2841							
5	103	1	7036	TRANSFER							
1	103	1	7038	33							
5	103	1	7055	TRANSFER							
1	103	1	7055	331F							
5	103	1	7086	TRANSFER							
1	103	1	7086	37							
5	103	1	7112	TRANSFER							
1	103	1	7112	712							
1	103	1	7139	41							
1	103	1	7145								
1	103	1	7152	2							
1	103	1	7157	21							
1	103	1	7163	211							
1	103	1	7183	21							
1	103	1	7189	212							
1	103	1	7202	21							

←——— Data Point (pointing to row with TIME 6251, FRAME 3314)

RECORD TYPE	SUBJ NO.	ORIG TIME	FRAME OR MESSAGE	OP UNIT POS	X POS	Y POS	MIS POS	SIT	ATT GEN	ATT BL	SUBORDINATE UNITS					WEAPON NUMBER	VOLLEYS	SORTIE
1	111	1452	3613															
1	111	1458	361															
1	111	1500	3616															
1	111	1510	3616															
1	111	1552	3616															
5	111	1621	TRANSFER															
5	111	1621	33142C															
4	111	1649																
5	111	1701	TRANSFER															
5	111	1701	2841															
5	111	1735	TRANSFER															
1	111	1735	2822															
5	111	1759	TRANSFER															
5	111	1802	2842															
5	111	1802	ERROR															
1	111	1803	2842															
1	111	1904																
5	111	1945	X															
5	111	1945	X2															
5	111	1956	SIT UPDATE 1															
5	111	1956	OV SS 1	306														
5	111	1956	TOTAL AIR															
5	111	1956	OV SS 2	350														
5	111	1956	OV SS 3	354														
5	111	1956	OV SS 4	5043														
5	111	1956	OV SS 5	5986														
5	111	1956	OV SS 6	100														
5	111	1956	OV SS 7	472														
5	111	1956	OV SS 8	3606														
5	111	1956	OV SS 9	4600														
5	111	1956	OV SS 10	5382														
6	111	1956	OV 6S 1	171														
5	111	1956	OV 6S 2	335														
6	111	1956	OV 6S 3	955														
5	111	1956	1F/2> DIV															
6	111	1956	EVNT 1 TIM 1															
5	111	1956	34TH DIV															
6	111	1956	EVNT 1 TIM 1															
4	111	1956	OV 6S 4	8/5														
4	111	1956	OV 6S 5	6375														
4	111	1956			4	321	245	2	17	99	999	5	6	7	0	0	1-208 MTZ BN	0	0
4	111	1956			8	332	241	2	17	94	999	9	10	11	0	0	2-208 MTZ BN	0	0
4	111	1956			12	320	290	5	36	100	999	13	14	15	0	0	3-208 MTZ BN	0	0
4	111	1956			16	321	224	2	17	99	99	17	18	19	0	0	1-208 TANK BN (MDM)	0	0
4	111	1956			20	405	275	5	36	100	100	21	22	345	349	383	208 REGT ARTY	0	0
4	111	1956			24	284	290	2	17	99	999	25	26	27	0	0	1-211 MTZ BN	0	0
4	111	1956			28	304	268	2	17	99	999	29	30	31	0	0	2-211 MTZ BN	0	0
4	111	1956			32	340	440	5	36	100	999	33	34	35	0	0	3-211 MTZ BN	0	0
4	111	1956			36	290	279	2	17	99	99	37	38	39	0	0	1-211 TANK BN (MDM)	0	0
4	111	1957			40	350	325	5	36	100	100	41	42	346	350	384	211 REGT ARTY	0	0

Table 3-3. Track File Summary: Combat Data

Section 4 Results

3.4.1 Overview

The results of the evaluation were reduced, analyzed and evaluated

separately for the planning and combat play sessions. Within each

session, the data was organized according to tactical performance and

information processing measures. Due to the preliminary nature of this

investigation, the analysis was largely descriptive in nature. According-

ly, means, standard deviations, and confidence intervals were the primary

statistics used to present the results.

For each measure within phases, the results were com ared between groups

(aided versus unaided), between style dimensions (Active versus Passive,

Logical versus Intuitive, and High Abstract versus Low Abstract versus

Concrete) and within style dimensions (aided versus unaided-Active,

aided versus unaided-Passive, aided versus unaided-Logical, etc.) These

comparisons addressed the experimental questions posed regarding both

aid efficacy and the interaction of aid, decision style, and performance.

The means and standard deviations for each measure across all groups

are contained in Tables 3-6 through 3-11. The graphs for each of the

measures are contained in Appendix B. The data in its entirety is

presented in the tables and graphs listed above; the remaining para-

graphs of this section will identify trends in the data according to

each measure. Further, the derivation and rationale for each measure

is presented.

The use of inferential statistics was limited due to the small sample

size and heterogeneity of variance, especially in the aided condition

group. This effect was further compounded in the style subgroups by

unequal sample sizes.

3.4.2 Decision Style Measurement

As previously indicated, the form of the adaptive estimate of the situ-

ation aid was determined by the scores on the Decision Style Measurement

Instrument (DSMI). At its present stage of development, the DSMI is

presumed to provide a nominal indication of style on each of three bi-

polar dimensions: Active-Passive, Logical-Intuitive, and Abstract-

Concrete. These three scales yield eight possible combinations of de-

cision styles. The styles observed in the study sample are presented

in Table 3-4.

A frequency plot of scores on the Abstract-Concrete dimension (Figure

3-3) yielded a distribution of one Concrete score, seven Low Abstract
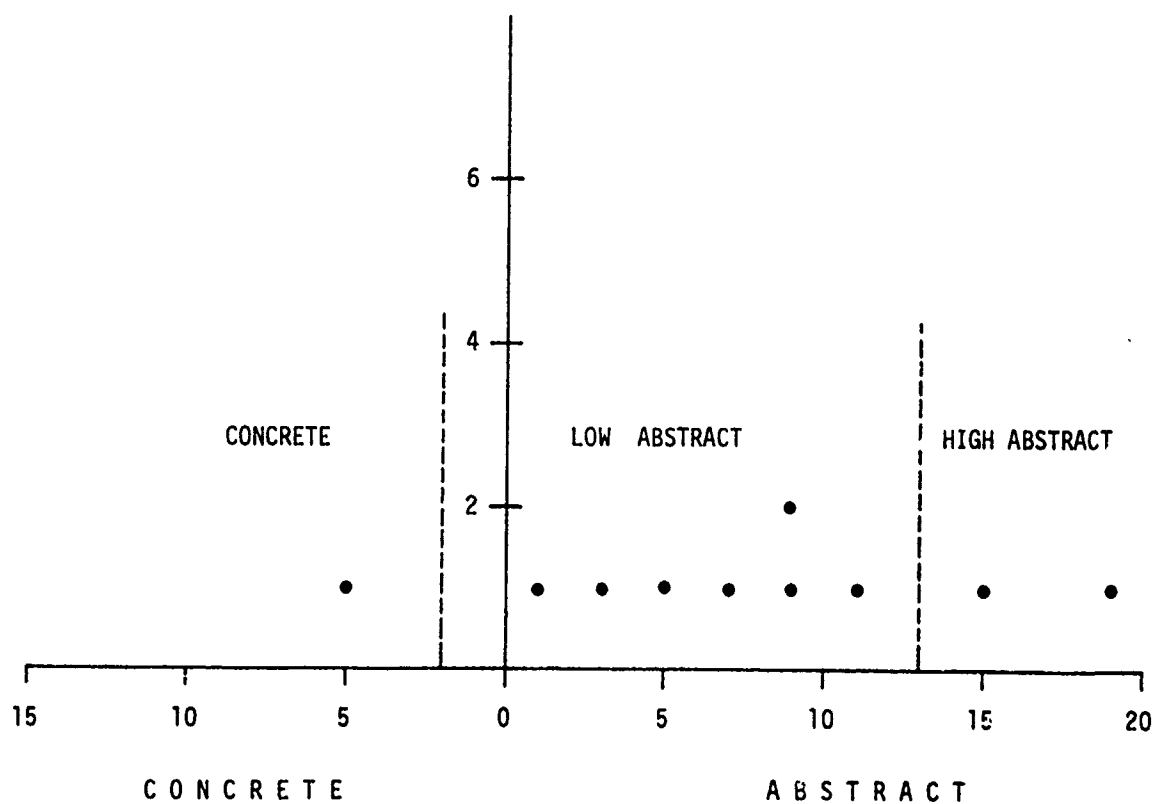
Figure 3-3.   Observed Scores from the DSMI on the Abstract-Concrete Dimension.

scores, and two High Abstract scores. When aided versus unaided groups

were compared using this dimension, only the Low Abstract individuals

were included, due to the small numbers involved. Although the High

Abstract and Concrete scores are shown in the tables and graphs, these

should not be considered as reflecting any trends in the data.

Table 3-4. Observed Decision Styles

Active/Abstract/Logical	1
Active/Abstract/Intuitive	3
Active/Concrete/Logical	
Active/Concrete/Intuitive	
Passive/Abstract/Logical	4
Passive/Abstract/Intuitive	
Passive/Concrete/Logical	
Passive/Concrete/Intuitive	1
Tie/Abstract/Intuitive	1
	10

3.4.3 Consultant Background

Background information was gathered on each of the participating tac-

ticians in the form of a post experimental questionnaire (Appendix A,

Exhibit 13). This information is summarized in Table 3-5. The aided

Table 3-5. Consultant Background Data Summary

	AIDED		UNAIDED		TOTAL	
Rank	Colonels Lt. Colonels Majors	1 3 1	Colonels Lt. Colonels Majors	1 3 1	Colonels Lt. Colonels Majors	2 6 2
Average Age	43.8		42		42.9	
Average Years of Service	20.5		18.6		19.6	
Type of Military Experience	Infantry ARMD CAU ARTY	3 1 1	ARMD CAU ARTY	3 2	Infantry ARMD CAU ARTY	3 4 3
Percent of G-3	40%		40%		40%	
Average Combat (Months)	12		10.4*		11.2	
Average Years since Graduation (CGSC)	8.2		6		7.1	
Education	Bachelor's Degree Graduate Work	5 3	Bachelor's Degree Graduate Work	5 3	Bachelor's Degree Graduate Work	10 6
Percent with Tactical Map Exercises (Germany	80%		40%		60%	

* Four of the five consultants had 12 months of combat.
   The fifth consultant, with 4 months of combat, reduced the mean
   to 10.4 months.

3.4.3 Consultant Background

and unaided groups were found to be similar on most characteristics.
The only discrepancies involved recency of attendance at Command and
General Staff College and participation in tactical field exercises in
Europe.

The recency factor favored the unaided group (2.2 years). While this
factor has been correlated with performance in SIMTOS, experience beyond
five years did not discriminate between participants (Krumm, Robins and
Ryan, 1973). Note that for the unaided group, the mean recency is six
years. The effects of the recency factor in the present evaluation
should be negligible.

The fact that four aided officers had participated in tactical field
exercises in Europe (as opposed to two in the unaided group) is likewise
of little consequence to the results of this study. The study partici-
pants who had field exercise experience held a variety of roles, and
any systematic effects could not be determined.

3.4.4 Planning: Tactical Performance

The planning session, to reiterate, consisted of two phases. The first
phase, the Recommendation of a Course of Action, consisted of the
assignment of the maneuver units to defensive positions. The second

phase, the Development of the 20th Mechanized Division Task Organization, contained the concept of the maneuvers and mission statements. In both phases the tasks required the G-3's to respond by filling in response sheets by hand. The scoring of these response sheets comprised the tactical performance evaluation of the G-3's during planning.

The procedure for scoring the planning response sheets was derived from Army Command and General Staff College Norms presented by the Bunker-Ramo Corporation (Bunker-Ramo, 1973). This procedure was used in the present evaluation of tactical performance for the planning session.

The scoring consisted of assigning (or not assigning, in some cases) points to segments of the G-3's written responses. The total possible points available with this procedure was 59. Earlier studies evaluating the planning session on SIMTOS obtained average scores of 27.1 with a range of 15 to 36 (Robins, Buffardi and Ryan, 1973). In the present evaluation, the mean score, with $N = 10$, was somewhat lower--23.7, with a range of 17 to 28. Note, however, that in the study by Robins and associates, the planning session was three hours long while in the present evaluation, it was only two hours.

Total scores for planning show that unaided individuals did slightly better than aided with a mean score of 24.8 (S. D. 3.42) in contrast to

the aided mean of 22.6 (with an S. D. of 4.16). The means are plotted

in Figures B-1, B-2, and B-3. Overall, the unaided groups scored slightly

higher than the aided group. Within the style groups, the unaided G-3's

tended to score higher than the aided G-3's.

3.4.5 Planning: Information Processing

Five measures were developed to evaluate the information processing of

the G-3's during the planning session. They are:

- sources sought

- action ratio

- redundancy ratio

- error ratio

- information acquisition ratio

The derivation of these measures from the data and the results are

described below.

The SIMTOS data base is divided into ten categories of information.

The first information processing measure, sources sought, is an indicant

of how many of these categories were used by the G-3 evaluators to

work the SIMTOS tasks. For each phase of the task, the measure was

derived by dividing the number of categories queried during a phase

by the number of categories available to query (i.e., ten). Thus, the higher the ratio, the more categories queried.

The means and standard deviations for the groups during planning for the sources sought measure are presented in Tables 3-6 and 3-7. The means are graphed in Figures B-4 through B-9. There is little difference between the aided and unaided groups in the number of sources sought during planning. The active and the intuitive groups, however, tend to query more categories than either the passive or logical groups, respectively.

The second information processing measure, action ratio, was derived for each phase by totaling the number of queries made in each of the ten categories and dividing this total into the number of times each category was queried. The resultant ratio indicates how individuals obtain their information from the data base. The higher the ratio, the more times categories were returned to for information.

The means and standard deviations for the action ratio during planning are shown in Tables 3-6 and 3-7. The graphs of the means are contained in Figures B-10 through B-25. There are almost no differences between the groups on this measure.

Error ratio, the third measure, was derived by dividing the total
number of system usage errors by the total number of interactions the
G-3's had with the system. Error ratio is an indicator of how well
the G-3's were able to master the operation of the system: the higher
the ratio, the more system usage errors.

The ratios for this measure were so small ($\leq$ .07) that no differences be-
tween groups appear. The means and standard deviations for planning
are shown in Tables 3-6 and 3-7, and the graph of the means for aided
and unaided groups are contained in Figure B-26.

The fourth measure, redundancy ratio, was derived by dividing the total
number of redundant queries by the total number of data base queries.
The ratio indicates the number of times the same piece of information
was queried by a G-3 during the task.

The means and standard deviations for planning are shown in Tables 3-6
and 3-7. The means for each phase have been graphed in Figures B-27
through B-33. Throughout the planning session, the aided group is
more redundant than the unaided group. Also, the intuitive group is
consistently more redundant than the logical group throughout planning.
In both phases of planning the active group is more redundant than the
passive group.

In the Procedure section, the method for querying the data base was
described in detail. The method forces the G-3 to choose one frame at
a time in a vertical manner through the data base structure. Since
each frame picked appears on the track file, a G-3's path can be fol-
lowed. A "data point" has been defined as the frame in the data
structure from which the G-3 starts to move back up the data structure
(i.e., either by returning to the previous frame or by returning to the
"General Index" frame). An example of a "data point" is shown by the
arrow in Table 3-2.

Information acquisition, the fifth measure was derived by totaling the
number of data points and dividing this total by the total number of
data base queries. The ratio shows how many responses were required to
obtain a piece of information. It is thus an indicant of either aid
usage or depth of query into the data base structure.

The means and standard deviations for information acquisition during
planning are shown in Tables 3-6 and 3-7. These means are plotted in
Figures B-34 through B-39. The aided group has higher ratios of infor-
mation acquisition than the unaided group during planning. Both the
intuitive and active groups have higher ratios than the logical and
passive groups, respectively.

The SIMTOS Defensive Scenario Combat Performance Scoring Criteria
(Bunker-Ramo, 1973) list five factors "determined to be of significant
importance in assessing combat performance during defensive operation."
They are:

- friendly force attrition

- enemy force attrition

- friendly force artillery expenditure

- friendly force air strikes expended

- distance surrendered

Two additional measures derived from the data and used in the present
evaluation were:

- events

- objectives reached

As events are the main indicants of success in operation of the simula-
tion, their explanation and derivation will be presented first.

In this simulation, directives for (instruction to) enemy units are
triggered by movement of those units. When enemy units penetrate a
specified distance into friendly territory (cross an event line), new
directives for that unit are issued by the computer. This process is
an "event," and the track file indicates after each update what event
combat is in. Thus, the event measure is the number of events triggered

by the advancing army across the updates. Because simulation operation centers around events, this measure should correlate highly with other combat measures.

Across all tactical measures, a deviation in performance was noted in one G-3 (#101). An example of this difference can be noted by looking at individual curves for this measure in Figure B-40. Participant #101, in contrast to the others in the study, held the enemy at two events from the second update until the end of the problem. In the graphs for this measure, a curve for each group of individual including #101 (where it is applicable) and another without #101 is shown to demonstrate the effect of his data upon the trends.

Table 3-8 shows the means and standard deviations for events at the end of the problem. Figures B-41 through B-50 depict the means for events graphed across update. Even when #101's performance is removed, the aided groups ends having triggered slightly fewer events than the unaided group. The events also occur less rapidly across updates for the aided group. However, there are almost no style differences for events without #101's performance.

Because of the increased variance caused by #101's data, the trends indicated in the graphs of tactical measures tend to be artificial. For this reason, although descriptive statistics are provided in Tables 3-8

and 3-9, and graphs for each measure are available in Appendix B, de-
tailed analysis of each measure will not be provided in the Results
Section.   Only those trends of particular interest will be discussed.
While the five factors listed by Bunker-Ramo (1973) were used in the
present evaluation, they were computed directly from the track files,
as described below, rather than according to the procedures detailed
by Bunker-Ramo (1973).

On the track files, the percentages shown under general attrition in-
dicate the remaining strength of units.   In order to compute attrition
(both friendly and enemy), percentage of losses were summed across all
units for a single update and divided by the total number of units
suffering losses by the end of the task.   This yielded an average
percentage lost per update for the friendly and enemy forces during
each G-3's combat session.

Table 3-9 shows means and standard deviations for <u>friendly</u> <u>force</u> <u>attri-</u>
<u>tion</u> for all groups.   Figures B-51 through B-60 provide a graphical
representation of the means across updates.   Although friendly force
attrition is a cumulative measure which yields only rising curves,
there is one case where attrition dropped between two updates (See *,
Figure B-52).   One G-3 (#101) recombined units in such a way that the
organization cancelled out losses that had previously occurred.

Excluding the attrition of #101's forces, there is almost no difference in friendly force attrition between aided and unaided groups or between styles.

The means and standard deviations for enemy force attrition are provided in Table 3-9. Figures B-61 through B-70 show the plotted means. While overall there is not much difference between the aided, unaided or style groups without the effects of #101, it is interesting to note that there is much more variability within the aided group than the unaided group in the percentage of enemy attrition.

Since each unit's coordinates are given after each update on the track file, a specific unit's path can be plotted. To derive distance surrendered, each enemy unit's path was measured (in centimeters and converted to kilometers) from the point at which it crossed the international border (the Weisse-Elster River) to its end-point after the 12th update. Average distance surrendered for each update was thus computed by summing the distance surrendered for all units and dividing by the total number of units that moved across the international border during the course of combat.

The means and standard deviations of distance surrendered are contained in Table 3-9. The means have been graphed in Figures B-71 through B-78.

Again, without the effects of #101, little or no difference is found between groups on this measure.

Friendly force weapon expenditures was broken down into the three types of artillery available and tactical air strikes. The percentage of available fire power used was calculated for each weapon for each update. For the artillery (155 millimeter guns, 8-inch guns and Honest Johns), the percentage consisted of the total number of rounds expended (summed for all batteries) compared to the total number of rounds available (the total available for each battery times the number of batteries). Tactical air expenditure was the percentage of planes dispatched during each update compared to the total number of planes available. (Once a plane was used, it was not available for the rest of the combat session.)

The means and standard deviations for this measure are presented in Table 3-8. Figures B-79 through B-114 show weapon expenditure for the three types of artillery and for tactical air strikes for each G-3. Again, without the effects of #101, the differences between groups are negligible.

Enemy units were given directives, according to event, to move toward a certain location or "objective." On the track file, the situation codes indicate when a mission has been accomplished. Objectives reached

is thus the total number of missions accomplished by all units across
all updates.

The means and standard deviations for objectives reached are contained
in Table 3-8.   The graphs of these means across updates for the aided
versus unaided participants are shown in Figure B-115.   G-3 #101's per-
formance for this measure again inflates any differences between groups.

3.4.7   Combat: Information Processing

This section contains the results of the evaluation of the G-3's in-
formation processing during the combat phases of the task.   The five
measures used to evaluate planning performance are again: sources sought,
action ratio, error ratio, redundancy ratio, and information acquisition
efficiency.   The derivation of these measures for combat data was the
same as described above for the planning data.   In addition, two measures
unique to resource allocation during combat were used: efficiency ratio
and firing time.

Tables 3-10 and 3-11 show the means and standard deviations for sources
sought during combat.   The means are graphed in Figures B-4 through B-9.
The aided and unaided G-3's sought approximately the same number of
sources during combat.   There is almost no difference between the logical

3.4.7 Combat: Information Processing

and intuitive groups on this measure. During the dynamic phase of combat, however, the active group sought more sources than the passive group, due to the larger number of sources by the unaided active G'3's.

The means and standard deviations during combat for the action ratio are presented in Tables 3-10 and 3-11. The means are plotted in Figures B-10 through B-25. While there is no difference during the dynamic phase of combat, the aided group has a higher action ratio than the unaided during the static phase of combat. However, little difference exists between style groups on this measure.

The error ratio means and standard deviations for combat are shown in Tables 3-10 and 3-11. The means are graphed in Figure B-26. Again, as for planning, the error ratios during combat were so small that no differences between groups appear.

Tables 3-10 and 3-11 show the means and standard deviations for redundancy ratio during combat. These means are graphed by group in Figures B-27 through B-33. The aided group is more redundant during combat than the unaided group. The intuitive group is slightly more redundant during combat than the logical. For the active and passive groups, however, the active G-3's are more redundant than the passive during the static phase, but the trend is reversed during the dynamic phase.

The means and standard deviations for <u>information acquisition ratios</u>
during combat are shown in Tables 3-10 and 3-11. Figures B-34 through
B-39 show these means graphed. The aided group has higher ratios in
combat. The intuitive group has a much higher ratio during the static
phase than the logical group, but there is little difference between
these groups during the dynamic phase.

The first measure of resource allocation during combat, <u>usage efficiency</u>,
was computed by dividing the total number of times that units were as-
signed to fire by the number of times the resources allocation loop was
entered. The ratio thus shows how many units were assigned to fire
each time the resource allocation loop was queried. To associate a
higher ratio with higher efficiency, all ratios obtained were subtracted
from one. The means and standard deviations for usage efficiency are
shown in Table 3-9. The means are graphed in Figures B-116 and B-117.
There is almost no difference between the aided and unaided groups or
between the logical and intuitive groups. The passive group, however,
has a higher usage efficiency than the active group.

<u>Firing time</u>, the second measure of resource allocation, was derived by
dividing the time spent assigning units to fire by the total number of
times units were assigned to fire. The measure thus shows the average
time spent to assign fires. The means and standard deviations for

firing time are shown in Table 3-9. The means have been graphed in Figures B-118 and B-119. The unaided group took longer to assign fire missions than the aided group. Although there was little difference between the active and passive groups, the intuitive group look longer to fire than the logical group, largely as a result of the unaided intuitive G-3's.

Table 3-6. Summary of Information Processing Results: Planning (Phase 1)

	Sources Sought		Action Ratio		Error Ratio		Redundancy Ratio		Info. Acquisition Efficiency	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Aided	.46	.33	.10	.05	.020	.010	.16	.07	.43	.17
Unaided	.40	.21	.06	.03	.010	.010	.07	.06	.30	.04
Active	.48	.37	.09	.04	.008	.013	.13	.07	.41	.19
Aided	.53	.42	.11	.03	.010	.020	.16	.08	.48	.22
Unaided	.40	.42	.07	.04	.005	.007	.09	.06	.30	.07
Passive	.38	.11	.06	.05	.012	.011	.10	.09	.33	.04
Aided	.35	.21	.07	.07	.010	.000	.17	.09	.37	.02
Unaided	.40	.00	.06	.04	.013	.015	.05	.06	.31	.03
Logical	.32	.16	.06	.05	.010	.012	.10	.09	.31	.05
Aided	.35	.21	.07	.07	.010	.000	.17	.09	.37	.02
Unaided	.30	.17	.05	.04	.010	.017	.05	.07	.28	.03
Intuitive	.54	.31	.10	.04	.010	.012	.13	.06	.42	.17
Aided	.53	.42	.11	.03	.010	.017	.23	.08	.48	.22
Unaided	.55	.21	.07	.03	.010	.000	.09	.05	.34	.01
High Abstract	.15	.07	.06	.03	.000	.000	.17	.06	.29	.06
Low Abstract	.51	.26	.09	.05	.013	.013	.10	.08	.40	.15
Aided	.53	.34	.10	.05	.013	.013	.15	.08	.46	.18
Unaided	.50	.17	.07	.04	.013	.015	.03	.03	.31	.04
Concrete	.40	--	.05	--	.010	--	.12	--	.33	--

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Table 3-7. Summary of Information Processing Results: Planning (Phase 2)

	Sources Sought		Action Ratio		Error Ratio		Redundancy Ratio		Info. Acquisition Efficiency	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Aided	.18	.13	.15	.21	.020	.020	.24	.09	.36	.09
Unaided	.24	.21	.15	.11	.010	.020	.18	.12	.34	.02
Active	.20	.12	.07	.07	.024	.022	.29	.05	.38	.07
Aided	.23	.15	.07	.09	.013	.023	.29	.07	.41	.09
Unaided	.15	.07	.08	.05	.040	.000	.29	.01	.34	.03
Passive	.22	.22	.13	.13	.008	.018	.14	.09	.32	.04
Aided	.10	.00	.02	.03	.020	.028	.17	.06	.29	.06
Unaided	.30	.26	.20	.12	.000	.000	.12	.12	.34	.02
Logical	.20	.22	.11	.13	.016	.022	.15	.11	.33	.05
Aided	.10	.00	.02	.03	.020	.028	.17	.06	.29	.06
Unaided	.27	.29	.18	.15	.013	.023	.13	.14	.35	.02
Intuitive	.22	.11	.19	.18	.016	.022	.28	.05	.38	.08
Aided	.23	.15	.24	.24	.013	.023	.29	.07	.41	.09
Unaided	.20	.00	.11	.00	.020	.028	.26	.04	.32	.00
High Abstract	.25	.21	.11	.09	.020	.028	.25	.05	.39	.04
Low Abstract	.20	.18	.17	.18	.017	.021	.20	.12	.35	.08
Aided	.13	.05	.15	.24	.020	.023	.25	.10	.35	.11
Unaided	.30	.26	.20	.12	.013	.023	.14	.15	.34	.02
Concrete	.20	--	.11	--	.000	--	.23	--	.32	--

Table 3-8. Summary of Tactical Performance Measures (Part I)

| | Friendly Force Weapon Expenditure | | | | | | | | Events | | Objectives Reached | | |
| | 155" | | 8" | | RJ | | TAC AIR | | | | | | |
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	CONFIDENCE INTERVAL
Aided	40.77	31.44	38.89	35.86	16.67	27.99	35.33	36.25	5.00	1.73	27.23	13.00	9.10 45.30
Unaided	25.77	12.31	20.00	13.44	10.00	8.00	17.33	9.25	6.00	0.00	32.20	.90	29.5 34.90
Active	40.77	29.81	38.52	37.18	19.45	26.93	38.00	34.85	5.00	1.73	.80	.84	
Aided	50.00	37.90	50.62	45.26	25.93	35.28	46.67	46.31	4.33	2.08	.67	1.15	
Unaided	26.93	6.66	20.37	18.33	9.73	9.82	25.00	2.36	6.00	0.00	1.00	0.00	
Passive	25.37	15.36	20.37	10.05	7.78	8.19	14.67	6.91	6.00	0.00	.60	.89	
Aided	25.93	19.64	21.30	3.92	2.78	0.00	18.34	2.35	6.00	0.00	1.00	1.41	
Unaided	25.00	16.69	19.75	13.90	11.11	9.62	12.22	8.39	6.00	0.00	.33	.58	
Logical	30.40	11.18	25.92	7.05	10.56	7.19	19.33	4.95	6.00	0.00	.60	.89	
Aided	25.93	19.64	21.30	3.92	2.78	0.00	18.34	2.35	6.00	0.00	1.00	1.41	
Unaided	33.39	4.87	29.01	7.48	15.74	1.61	20.00	6.67	6.00	0.00	.33	.58	
Intuitive	35.74	33.62	32.96	40.11	16.11	28.36	33.33	38.15	5.00	1.73	.80	.84	
Aided	50.00	37.90	50.62	45.26	25.93	35.28	46.67	46.31	4.33	2.08	.07	1.15	
Unaided	14.35	11.13	6.49	1.31	-1.39	1.97	13.33	14.14	6.00	0.00	1.00	0.00	
High Abstract	36.19	6.43	37.04	5.24	9.73	5.89	25.00	2.36	5.50	.71	.50	.71	
Low Abst.	35.98	26.66	30.69	31.71	16.27	23.10	30.00	31.03	5.43	1.51	.71	.95	
Aided	40.28	36.30	38.43	41.39	19.45	31.51	38.34	41.14	5.00	2.00	1.00	1.15	
Unaided	30.25	8.35	20.30	12.96	12.04	8.02	18.89	5.09	6.00	0.00	.33	.58	
Concrete	6.46	—	5.56	—	0.00	—	3.33	—	6.00	0.00	1.00	—	

Table 3-9. Summary of Tactical Performance Measures (Part II)

	Resource Allocation — Usage Efficiency		Firing Time		Friendly Force Attrition			Enemy Force Attrition			Distance Surrendered		
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Confidence Interval	Mean	S.D.	Confidence Interval	Mean	S.D.	Confidence Interval
Aided	.44	.38	40.60	17.09	33.92	11.28		25.81	13.26		314.76	127.71	137.50 – 492.02
Unaided	.40	.27	47.51	15.89	37.36	1.28		18.29	8.53		367.30	1.44	365.30 – 369.30
Active Aided	.53	.26	45.27	19.48	33.60	11.10		24.83	14.30		312.14	126.05	137.18 – 487.10
	.48	.34	41.00	16.20	30.52	14.53	18.10 – 49.10	31.28	15.21	5.00 – 44.70	275.93	163.89	
Unaided	.59	.16	51.67	29.26	38.22	1.31		15.17	6.34		366.45	2.05	
Passive Aided	.32	.35	42.83	13.84	37.68	1.50		19.27	7.80		369.92	7.83	38.79 – 359.04
	.37	.57	39.99	25.35	39.03	.57	35.60 – 39.70	17.61	4.09	8.40 – 30.20	373.00	14.56	
Unaided	.28	.27	44.73	6.94	36.79	1.09		20.38	10.48		367.67	1.07	
Logical Aided	.42	.38	38.61	13.52	38.35	1.10		21.26	5.80		369.14	8.15	357.83 – 360.45
	.37	.57	39.99	25.35	39.03	.57	36.80 – 39.90	17.61	4.09	13.20 – 29.30	373.00	14.57	
Unaided	.45	.34	37.69	6.43	37.90	1.26		23.69	6.07		356.57	1.38	
Intuitive Aided	.42	.28	49.49	17.82	32.93	10.80		22.85	15.80		312.76	126.38	137.34 – 488.16
	.48	.34	41.00	16.20	30.52	14.53	17.90 – 47.90	31.28	15.21	0.90 – 44.80	275.93	163.89	
Unaided	.33	.21	62.23	14.33	36.54	1.06		10.20	.68		368.00	3.90	
High Abstract	.61	.13	41.23	14.50	37.71	2.02	12.01 – 63.40	30.28	15.03	160.73 – 221.29	368.50	5.16	303.06 – 434.24
Low Abst. Aided	.40	.35	43.71	18.29	35.03	9.40		21.46	10.17	11.30 – 31.62	329.16	107.11	222.16 – 436.16
	.42	.43	37.88	18.44	33.34	12.94		22.04	11.81		300.37	142.71	
Unaided	.38	.27	51.49	18.28	37.29	.67		20.69	9.97		367.53	0.40	
Concrete	.18	--	52.09	--	35.79	--		9.72	--		368.90	--	

Table 3-10. Summary of Information Processing Results: Combat Hold

	Sources Sought		Action Ratio		Error Ratio		Redundancy Ratio		Info. Acquisition Efficiency	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Aided	.16	.05	.17	.12	.070	.070	.43	.29	.59	.33
Unaided	.14	.05	.04	.02	.010	.010	.14	.11	.27	.15
Active	.14	.05	.13	.14	.048	.080	.35	.36	.53	.38
Aided	.13	.06	.19	.17	.070	.104	.54	.35	.73	.37
Unaided	.15	.07	.05	.04	.015	.007	.06	.00	.22	.04
Passive	.16	.05	.08	.07	.030	.042	.22	.10	.33	.15
Aided	.20	.00	.15	.03	.075	.021	.27	.09	.37	.10
Unaided	.13	.06	.03	.01	.000	.000	.20	.11	.31	.19
Logical	.16	.05	.09	.06	.034	.040	.31	.26	.28	.10
Aided	.20	.00	.15	.03	.075	.021	.27	.09	.37	.10
Unaided	.13	.06	.05	.02	.007	.012	.11	.05	.21	.04
Intuitive	.14	.05	.12	.15	.044	.082	.40	.32	.58	.35
Aided	.13	.06	.19	.17	.070	.104	.54	.35	.73	.37
Unaided	.15	.07	.02	.00	.005	.007	.19	.18	.36	.24
High Abstract	.10	.00	.08	.01	.020	.000	.10	.06	.28	.04
Low Abstract	.17	.05	.13	.12	.050	.071	.33	.29	.46	.34
Aided	.18	.05	.20	.12	.085	.079	.50	.28	.66	.34
Unaided	.17	.06	.03	.01	.003	.006	.11	.05	.19	.02
Concrete	.10	--	.02	--	.000	--	.32	--	.53	--

Table 3-11. Summary of Information Processing Results: Combat Release

	Sources Sought		Action Ratio		Error Ratio		Redundancy Ratio		Info. Acquisition Efficiency	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Aided	.32	.22	.23	.07	.060	.020	.48	.21	.52	.30
Unaided	.36	.23	.23	.14	.070	.050	.36	.23	.47	.18
Active	.46	.25	.23	.08	.070	.035	.39	.26	.46	.29
Aided	.37	.29	.24	.10	.063	.025	.54	.22	.53	.38
Unaided	.60	.14	.20	.04	.080	.057	.16	.06	.34	.07
Passive	.28	.13	.24	.14	.072	.045	.45	.19	.54	.19
Aided	.25	.07	.22	.01	.060	.000	.38	.22	.51	.26
Unaided	.30	.17	.25	.19	.080	.062	.50	.20	.56	.18
Logical	.32	.22	.27	.10	.078	.036	.41	.24	.52	.21
Aided	.25	.07	.22	.31	.060	.000	.38	.22	.51	.26
Unaided	.37	.29	.31	.12	.090	.046	.44	.29	.53	.23
Intuitive	.36	.23	.19	.11	.064	.043	.43	.22	.48	.28
Aided	.37	.29	.24	.10	.063	.025	.63	.15	.53	.38
Unaided	.35	.21	.12	.07	.065	.078	.25	.07	.39	.00
High Abstract	.45	.35	.23	.02	.040	.000	.31	.26	.46	.23
Low Abstract	.33	.20	.26	.10	.089	.030	.47	.22	.52	.26
Aided	.35	.24	.24	.08	.068	.015	.47	.24	.50	.34
Unaided	.30	.17	.29	.15	.117	.015	.47	.25	.56	.18
Concrete	.20	--	.07	--	.010	--	.30	--	.39	--

Section 5   Discussion

3.5.1   Overview

In this section the relationship between the observed performance in this
preliminary investigation and the implemented decision aiding complex
will be presented.   Since the aiding complex differed in both a qualita-
tive and a quantitative fashion between the planning and combat sessions,
the discussion will treat these sessions separately.

It was hypothesized that in both sessions the aided group's performance
would be superior to that of the unaided group on both tactical and
information processing measures.   The ability to answer these questions
definitively requires a large sample of G-3 officer consultants due to
the characteristically high performance variability in tasks as com-
plex as those in the SIMTOS scenario.   This was not the case in the
present investigation.   Therefore, much of this discussion will involve
subjective interpretation of the data in an effort to identify meaningful
performance trends.

There is an inherent difficulty in the implementation and evaluation of
a decision aiding complex, especially when realistic operational tasks
are involved, as in this case.   The ultimate criterion in SIMTOS is

performance on the tactical measures collected during the combat session.
Yet, although this performance cannot be aided directly because it is
the result of series of intermediate decision and actions, it is these
activities to which the aid must be linked. Therefore, the analysis
must determine the extent to which the G-3's information processing
behavior was influenced by the aiding complex. Furthermore, the analysis
must define the actual relationships between G-3 information seeking,
information processing, and action selection behaviors and G-3 tactical
performance.

3.5.2 Aid Utility - Planning

Regarding the estimate of the situation evaluation, one can draw two
general conclusions. First it must be stated that during the planning
phase there were no differences between the two groups in their tactical
scores. Second, relative to previous studies (e.g., Robins, Buffardi
and Ryan, 1973), planning scores were lower.

The data on aid usage shows that the estimate aid was virtually unused
during the planning sessions. This data indicated that only three of
the five participants in the aided group even accessed the aid. Further-
more, the total aid usage constituted only a minute fraction of all
system interactions. Therefore, during planning the two groups behaved

in very similar fashion, and one would expect no differences in
overall performance.

One factor which certainly impacted aid disuse was the observed fact
that the study participants could, on the basis of their professional
experience alone, perform the planning task. They fell far short of
the maximum possible score, but this was probably due to time constraints.
Thus the focus of activity was upon the paper and pencil task--not upon
the automated tactical operations system.

The lack of estimate of the situation aid utilization can be summarized
in terms of the man-computer dialog criteria.[11] The aid took the form
of a list of frame titles containing information from the data base that
was considered to be necessary for successful completion of the planning
phase either in terms of frame content (as an index to the detailed data
required) or development of graphic situation overlays (e.g., avenues
of approach, key terrain features). To the extent that these frame
titles were not perceived to be relevant to the planning task, it might
be hypothesized that they would not be utilized. This inference is
supported by the actions of the two aided individuals categorized as
Passive. Both were instructed to review the estimate frames. One

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[11] Volume 1 of this report develops the rationale and antecedents
for these criteria.

participant looked at the f⁴; ∘t four aid frames and then proceeded to
query the data base in greater detail. All subsequent interactions
were with the standard data base. The other passive, aided participant
did not access the aid at all. This constitutes a dramatic failure of
the aid in terms of user acceptance.

Given that there were no group differences in tactical performance, were
there any differences in information processing?

The number of categories queried (sources sought measure) was the same
for the aided and unaided participants. This suggests that there was
a consistency in the types of information that the participants were
interested in.

Information acquisition, since the aid was not accessed, reflects the
depth of information query into the data structure. The aided group,
in accordance with their higher ratio, did not query to the same level
of detail that the unaided group did. This led to the conclusion that,
even though the aid was not perceived as directly useful to the planning
task, it did enable the aided G-3's to form a representation of the
data base (called a data base description). This, in turn, led to less
detailed information acquisition. This effect, if real, should be
reflected in superior system and data base usage during the combat
session.

The error ratio measure was extremely low for all groups (the maximum number of system of errors being six during the planning session). Mention must be made of the distinction between an error in system usage, which appears on the track file, and an error in information selection and retrieval. An error of the latter category is one in which the user operates the system correctly but either fails to find his desired information or retrieves what would appear to be wha: is wanted but in fact is not. This kind of system error is not displayed on the track file, but heavily impacts system use and acceptance.

To summarize, the planning session results indicate that the aided group neither used the aid to any significant degree nor performed better than the unaided group. By using the aid, we mean transferring the data frame contents to the primary CRT. The proposed alternative was use of the aid to gain a specific idea of data base contents through frame titles. There was no direct measure of this form of use except inferentially via the information usage efficiency measure.

3.5.3 Aid Utility - Combat Session

The picture in the combat session is very different from that in planning. Foremost, the aids (both estimate and resource allocation) were

used by the study participants. Not only the system but the aid operated
in a dynamic fashion. The task required the G-3 to interact closely
and knowledgeably with SIMTOS--not with some external response sheet.
The aided users were assisted in this task by system initiated communi-
cation, a key element of effective man-computer dialog.

The estimate of the situation aid for the combat session focused upon
two types of information. One was key information in the data base
which differed from that in the planning session. The other was in-
telligence information on the location of enemy first echelon forces
and the location of friendly general outpost (GOP) forces. This aid,
if used in conjunction with the resource allocation aid, enabled the
G-3 to direct his fire support and tactical air expenditures in an
efficient manner.

Interestingly, the advantage given by the estimate aid is best indicated
by the activities of the participants during the initial static portion
of the combat session. During this period the unaided group set up
their standing requests for information (SRIs). These lists bore a
remarkable congruence to the estimate aid available to the unaided
group. Thus, the two groups differed little in terms of the content
of the information available to them via the SRI mechanism, although
again there were large individual differences in the number of SRIs
(e.g., one unaided user did not set up any).

What was different was the saliency, timeliness, and accessability of
the information. In each case, the aided group had the advantage.
During the static combat phase this group scheduled five missions,
and in general became familiar with the task situation. The ability
of the aided group to use rather than initialize the system gave them
a distinct advantage in the combat play phase. The aids in essence
enabled some system users to effectively stop or slow the invasion.

The overall performance in the tactical criteria can be summarized
in Figure B-40 showing scenario events plotted by problem update.
Preplanned mission directives were scheduled for all offensive (enemy)
units. These directives were ordered executed as a function of geo-
graphic penetration into the defensive section. When the defensive
(friendly) player slowed or stopped these lead units, the total in-
vasion was halted. (Note that one participant was able to do just
that.) In Figure B-41 this individual was plotted separately. When his
data is added to the remainder of the aided group, the slight advantage
enjoyed becomes much greater. This effect is observed in all of the
tactical performance measures.

When the data from this G-3 is analyzed in more detail, one finds he
used the aid earlier in the problem and to a much greater extent. He,
in fact, played the game in an optimum fashion.

All tactical performance measures were highly interconnected. This
can be best illustrated by considering weapon expenditure (Figures B-79
through B-82) and enemy force attrition (Figures B-69 and B-70). Note
that for the unaided group the slope is relatively constant across up-
dates for these measures. This is not the case for the aided group.
For each participant in this group there is a point of sharp increase
in weapon expenditure which is mirrored by a corresponding increase in
weapon effectiveness in terms of impact upon the enemy attrition. One
finds further that this increase in slope occurs at varying points in
the problem for different G-3's. The fact that it occurs at all is
reflected in the slight overall superiority of the aided group during
combat. The observation that one individual "discovers" the relation-
ship during the static portion of the problem accounts for his over-
whelming superiority. For him the task was completed by the sixth
update.

A final comment regarding the tactical performance measures is that
there was a convergence toward the end of the problem between the
aided and unaided groups. The aid was most effective in the early
stages of the problem (i.e., during the static pre-update phase and
during the first few updates). This can be accounted for by the form
of the estimate aid. Following the first system update, the CRT
displaying the aid contained the frame titles of those frames included

in the aid which had changed. Since this information was also dis-
played on the line printer, the advantage of the aid was in terms of
timeliness of presentation and direct information accessability. As
the problem progressed and units either reached their objectives or
were halte . the number of data base changes decreased. Since the two
groups had similar information in their SRI/estimate aid files, the
initial advantage enjoyed by the aided group decreased.

At the conclusion of the planning session, all participants were asked
to generate a candidate SRI list. This could have been used to generate
an individualized estimate aid for the combat session; however, time
constraints and system inflexibility prevented this during the pre-
liminary study. These lists were reviewed for context against the
information included in the planning and combat estimate aids. Although
there was much individual variability in information requirements,
there was relatively high agreement between the type of information
the participants said they needed and what was available. This pro-
vides some validation of the aid content. The information considered
essential by an individual did not necessarily correspond, however, to
the information the study participant actually accessed. This finding
is in agreement with other studies using verbal protocol data (e.g.,
Alden, Heaton, and Henke, 1972). This area is a fruitful one for addi-
tional research in terms of developing decision aids responsive to
individual users.

The data on usage of the resource allocation task aid available to both groups support the above contentions. Two measures were used to assess the effectiveness of the resource allocation aid. One was efficiency of use in terms of missions scheduled by times the aid was accessed. The aided group was more efficient suggesting they had the target co-ordinates extracted and were more facile in using the system. A second measure was actual time in the aid loop; again the aided group was superior. A conclusion one draws from this is that the estimate aid enabled the aided group to extract the data necessary to schedule its fire missions and then execute these missions in a more efficient and timely fashion.

The analysis of the other information processing measures recorded during the combat session indicated essentially the same thing as in planning. Where use of the estimate aid impacted these measures, such as in redundancy (accessing the same frame repeatedly) or information usage efficiency (data frames retrieved versus number of frames queried), the aided group tended to have higher ratios. It must be noted, however, that redundancy in this session is related to importance of the infor-mation. The more critical the information is perceived to be to the scenario, the more likely it is to be redundantly retrieved.

It was hypothesized that, due to the homogeneity of the population from which our sample of participants was to be drawn, only some of the possible decision styles from the DSMI would be represented. The participant background data highlights the homogeneity of the sample. Although five of the eight decision styles wer found, two of the five contained 70% of the participants. (See Table 3-4.)

The small size of the evaluative sample is reduced even further when participants are grouped by style. Again, any definitive conclusions about style and performance are precluded. In order to determine any trends in the data, the tactical and information processing measures were examined according to single style dimension.

Consistent differences were found during planning in the comparisons between the active and passive and between the logical and intuitive participants on sources sought measure, on redundancy and on information acquisition. As would be predicted, the active decision makers search more information categories (seek more sources) than the passive. The active individuals are also more redundant and have a higher information acquisition rate than the passives.

As indicated in the results, there are two ways in which the information acquisition ratio would be high: through aid usage or by depth of the search into the data base structure. Since the aid was not utilized

during planning, the higher ratio indicates that the active individuals were not seeking the level of detail that the passive individuals were.

The intuitive participants sought more sources, were more redundant, and also had a higher information acquisition ratio than the logical participants. The intuitive decision maker would need to search more categories to get an overall estimate of the situation. In doing so, more interrelationships might become apparent causing him to recheck some of the information. Also, the intuitive individual needs less detail. These observations reflect the organization of the data base— logical and sequential.

3.5.5 Conclusions

The evaluation presented in this report was preliminary in nature. Due to the small number of participants and high individual performance variability, the data was subjectively interpreted in an effort to identify meaningful performance trends. This interpretation led to the conclusions described below concerning the estimate of the situation aid during planning and combat and the resource allocation aid during combat.

3.5.5 Conclusions

The planning task was oriented toward completion of a series of response sheets describing the defensive operation. This required little system interaction for a knowledgeable and experienced operations officer. When the constraints of time became apparent to the study participants, all system use decreased. This implies that not only was the aid not perceived as useful, but the system as a whole was not perceived as relevant to the planning task. Future studies of decision making in SIMTOS must make the planning phase more relevant to the plan executed during the combat phase.

During the combat session, the estimate of the situation aid was used to a much greater extent than during planning. Also, the resource allocation aid was used by all participants. The trends of the data indicated that the sooner the role(s) of the aid(s) were perceived by the system users, the more effective their performance. The man/computer dialog again played a key role in aid utility. The factors of aid perceived usefulness, flexibility, accessability, timeliness and inter- action between the aids led to the aided group's performing in a gen- erally superior fashion.

This is by no means an indication that the aids are in a polished form. Rather the content and form of the aids were generally acceptable but need refinement so that the initial gains can be exploited. The

3.5.5 Conclusions

responsive capability of each user must be further enhanced. Also, the aids must be more oriented to the primary G-3 task requirements. One can conclude from the trends that we are on the correct track.

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APPENDIX A

DEFENSIVE SCENARIO EXHIBITS

EXHIBIT 1

Situation

During the past three months, the political situation in Europe has deteriorated rapidly. Diplomatic relations have been broken off between Circle Trigon and Western governments, including the U.S. There has been considerable military activity along the entire West German-Circle Trigon Border during recent weeks. This activity is being "covered" under the pretext of conducting annual fall maneuvers.

To counter the military threat of the Circle Trigon build-up, the 30th U.S. Army has been airlifted to Germany to supplement NATO forces. The 30th Army is now in assembly areas along the Circle Trigon Border, with the 1st and 2nd Corps on the north and the 3d Corps in the south.

The 20 Inf. Div. (Mech) is a reserve unit, recently mobilized. It is within the 3d Corps and is now on combat alert in an assembly area in West Germany. The 3d Corps has been directed by 30th Army to prepare to defend the KASSEL (NB3585), ERFURT (PB4348), SCHWEINFURT (NA8845) triangle.

Assume that you are the G-3 of the 20 Mech Div. Your role will be:

a. To complete portions of the defensive planning to accomplish the 20 Mech Div. mission as specified in 3d Corps OPORD 63, and

b. To supervise and execute a defense of the division sector during an attack from the east.

No contingency plans are available. OPLANS are badly out of date.

EXHIBIT 2

(CLASSIFICATION)

3D CORPS
KRONACH (PA6668)
142100SEP74

OPORD 63

REFERENCE: Map, HOF-PLAUEN, 1:50,000; GERMANY, 1:250,000

TASK ORGANIZATION:

1. SITUATION:

    a. Enemy Forces: Annex A, Intelligence

    b. Friendly Forces:

        (1) 1st Corps and 2nd Corps prepare defensive positions on north
             (left) flank of 30th Army.

        (2) 3d Corps prepares defensive positions in sector from BERGA
             (TS9926) to HAZLAU (UR0760)

        (3) Elements of 9th AF provide Tac Air support

    c. Attachments and Detachments: Task Organization

2. MISSION:

    3d Corps to move immediately to defensive positions and in event of

attack defend in sector for up to 30 days to permit build-up of NATO forces.

3. EXECUTION:

    a. Concept of Operation: Annex B, Operation Overlay

        (1) Maneuver

             3d Corps to establish defense in sector with the 57th Inf. Div.
             (Mech) on the north, 20th Inf. Div. (Mech) in the center and
             74th Inf. Div. (Mech) in the south. The 56th Armor Div., Corps
             reserve vic NORDHALBEN (PA7883). Line divisions establish GOP
             NLT 150600SEP74.

        (2) Fires

             Priority of arty and tac air support to 57th Mech. Div., 20th
             Mech Div., and 74th Mech. Div. in that order, and to Corps
             counter-attacking forces on commitment. Annex C, Fire Support.

(CLASSIFICATION)

A-3

(CLASSIFICATION)

b. 20 Mech. Div.

   (1) Prepare to defend in sector.

   (2) Prevent enemy from penetrating west of hills 729 (PA8678), 795 (PA8873), and 726 (PA9066).

   (3) Establish GOP.

c. 74 Mech Div.

   (1) Prepare to delay in sector.

   (2) Canalize enemy along SELB(TR9562)

   (3) Establish GOP.

d. 57th Mech Div.

   (1) Prepare to defend in sector.

   (2) Prevent enemy from penetrating west of GORKWITZ (PB9798) GORITZ (PA9890) Autobahn.

   (3) Establish GOP.

e. Arty:

   (1) FA:

      (a) 61 Arty Gp: GSR 20 Mech. Div

      (b) 62 Arty Gp: GSR 57 Mech. Div

      (c) 63 Arty Gp: GSR 74 Mech. Div

      (d) 401 Arty Gp: GS

      (e) 2-631 (155) (SP) Arty: Atch 20 Mech Div

   (2) ADA:

      (a) 1-439 Arty: Atch 20 Mech Div

      (b) 2-439 Arty: GSR 74 Mech Div

      (c) 3-439 Arty: GSR 57 Mech Div

f. 301 Cml Bn (Smoke Genr): Atch 74 Mech Div

g. 51 Engr Bde:

   (1) Support defensive operations employing 56th Engr Bn (CBT) on the north, 54th Engr Bn (CBT) center, and 55th Engr Bn (CBT) in the south.

(CLASSIFICATION)

    (2) Priority of effort in order, construction of blocking positions, preparation of obstacles, and road maintenance.

h. Aviation:

    (1) 129 Avn Bn: DS 20 Mech Div

    (2) 130 Avn Bn: DS 57 Mech Div

    (3) 131 Avn Bn: DS 74 Mech Div

i. SUPCOM

    (1) Remain in present position

j. Res:

    (1) 56th Armd Div

        (a) Be prepared to ctr-atk in Corps north flank area.

k. Coordinating Instructions:

    (1) Units will construct obstacles as required to cause maximum restriction to enemy movement. Roads or other high-speed avenues of approach will be blocked in depth. Barriers will canalize enemy attack into killing area.

    (2) Destruction of population centers and communications, transportation, utilities, mining, factories, and port facilities will be minimized.

    (3) Use of chemical contaminants requires specific Army approval.

    (4) Any destruction that may have strategic impact will require Army approval prior to execution.

    (5) Barrier and denial operations must not unduly restrict future Army operations particularly to the north.

    (6) Gaps and lanes in Army directed barriers behind FEBA to be closed only on Army order.

    (7) Nuisance mines will not be authorized.

    (8) Barrier construction may be initiated without further orders.

    (9) Nuclear expenditures are not authorized.

4. SERVICE SUPPORT
   ADMIN/LOG PLAN 63:

5. COMMAND AND SIGNAL:

(CLASSIFICATION)

(CLASSIFICATION)

    a. Signal

        (1) SOI Index 1-3

        (2) Annex, E, Signal

    b. Command: Corps Tac CP with 74th Div.

Acknowledge.   MALONE
                                                    MG

Annexes: A-Intelligence (omitted)
          B-Operation Overlay
          C-Fire Support (omitted)
          D-Engineer (omitted)
          E-Signal (omitted)

Distribution: A
               2nd Corps

OFFICIAL
/S/FARLEY
  G3

EXHIBIT 3

Planning Activities (Morning Session)

Your planning sequence will be divided into two phases:

● Recommendation of a Course of Action

● Development of the Operations Plan

Your staff aid will provide you with the "commander's guidance" and your specific task requirements at the beginning of Phase I.

When you have completed your Phase I planning tasks, contact the experimenter via the telephone (press 7R). He will then provide you with the "commander's guidance" and your specific task requirements for Phase II.

When you have completed your Phase II planning tasks, contact the experimenter via the telephone (7R). You will then have a break before participating in the combat session. You will have a maximum of one hour for each of these phases.

Administrative Note

If you have to leave your work station any time during today's problem, please contact the experimenter via the telephone as you leave, and when you get back. In this way, our time records will show only the time you were actually working on the problem.

Date/Time

For purposes of the study, assume that today's date is 14 September 1972 and it is now 2100 hours.

EXHIBIT 4

GUIDE TO THE SIMTOS DATA BASE

GENERAL INDEX

G-1 Personnel	G-2 Intell.	G-3 Ops.	G-4 Loc.	G-5 Civ. Aff.	Fire Support	CBR	Sig.	Trans.	Eng.
①	②	③	④	⑤	⑥	⑦	⑧	⑨	⓪

20th MECH. DIV. TASK ORGANIZATION

20th MECH DIV. ORGANIC UNITS — ①

20th MECH DIV. SUPPORT UNITS — ②

1 BRIGADE ①   2 BRIGADE ②   3 BRIGADE ③   DIV. BASE ④

1-66 MECH BN ①   1-67 MECH BN ②   1-68 MECH BN ③

COMPANY A/1-66 MECH. ①   COMPANY B/1-66 MECH. ②   COMPANY C/1-66 MECH. ③

1st PLATOON   2 PLATOON   3 PLATOON
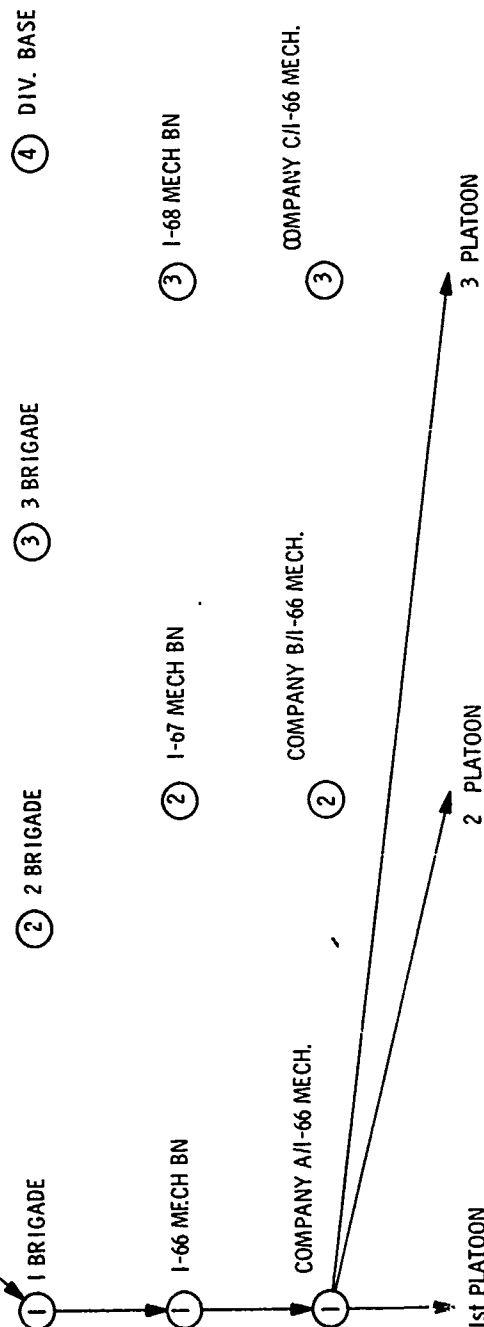
EXHIBIT 5

20 INF DIV (MECH)
142100SEP74

TO: G3

FROM: CMDR

SUBJECT: Recommendation of a Course of Action

You are requested to prepare recommendations to accomplish the 20 Inf. Div. Mission as indicated in OPORD 63. Base your work on the following considerations:

1. Form of Defense

   Considerations of terrain and relative mobility are most significant. The rugged terrain along the Saale River (QA0187-QA0973) provides good cover and concealment, excellent observation of the river valley and good to excellent fields of fire. Therefore, division planning will proceed on the basis of an area defense.

2. Mission

   (a) Our mission is to defend along the Saale River line in sector.

   (b) We must employ a general outpost. The Corps Commander has not specified the location of a GOP. Organize and locate the GOP with sufficient strength to provide at least 24 hours for us to prepare blocking positions.

3. Organization of Defense Sector

   We will organize our defense sector and conduct the defense primarily to retain terrain in the forward defense area taking maximum advantage of the Saale River obstacle. The ridge formed by Hills 715 (PA8678), 794 (PA8873), and 726 (PA9066) must be retained to support corps counterattack operations. The division reserve must be located where it can block penetrations, counterattack to regain terrain, and add depth to the defense.

4. Course of Action

   (a) In developing a course of action consider retention of key terrain and the obstacle value of HOF (QA0878).

(b) Your recommended course of action should consider the enemy capability of attacking in the 20th Div Sector with two or three divisions supported by artillery and air. Tactical infiltration may be employed. It is assumed that nuclear weapons will not be used.

5. Deadline

Your recommendation is reqd nlt 150001SEP.

SMITH
Commander

A-10

EXHIBIT 6

INSTRUCTIONS:

A.   On response Sheet #1, complete the following:

    1.   Allocation of CBT Power to Echelons of Defense

       a.   GOP Force by Unit

       b.   FDA Force by Unit

       c.   Reserve Force by Unit

    2.   Specific type of resistance by each echelon of defense (delay, screen, defend).

B.   On 1:50,000 SITMAP overlay, indicate location of:

    1.   GOPL

    2.   COP coordination point

       You will have one hour to complete the above, contact aide via the telephone (7R) at that time.

RESPONSE SHEET #1

ALLOCATION OF COMBAT POWER TO ECHELONS OF DEFENSE

Column (1) MISSION: Enter one of the following: delay, defend, screen,
        reconnoiter, counterattack.

Column (2) SECTOR: Indicate the portion of the 20 Mech Div sector in which
        the major unit will operate. Enter reserve, rear area security, or
        north, center, south on FDA.

Column (3) AVENUE: Enter Avenue or Avenues of Approach against which the
        unit will operate (A, B, C, D, E) as appropriate.

Column (4) SUBORDINATE UNITS: Enter all maneuver and support units allocated
        to the Bde headquarters, and indicate GOP composition by an asterisk
        (*). Cross-attach company sized units if you wish. If unit is in
        support role, indicate GS, GS Reinf., or DS.

MAJOR UNIT	(1) MISSION	(2) SECTOR	(3) AVENUE(S)	(4) SUBORD UNITS
1 BDE	_____	_____	_____	_____
			_____	_____
			_____	_____
			_____	_____
			_____	_____
				_____
				_____
				_____
				_____

MAJOR UNIT	(1) MISSION	(2) SECTOR	(3) AVENUE(S)	(4) SUBORD UNITS
2 BDE	_____	_____	_____	_____
			_____	_____
			_____	_____
			_____	_____
			_____	_____
3 BDE	_____	_____	_____	_____
			_____	_____
			_____	_____
			_____	_____
			_____	_____
DIV TRP	_____	_____	_____	_____
			_____	_____
			_____	_____
			_____	_____
			_____	_____
DIVARTY	_____	_____	_____	_____
			_____	_____
			_____	_____
			_____	_____
			_____	_____

EXHIBIT 7

INSTRUCTIONS:

1. On Response Sheet #2, write your recommended Div. Task organization. Indicate type of relationship to BDES, div. troop and divarty: (attached, DS, GS REINF, or GS).

2. On Response Sheet #3, write your recommended maneuver plan and mission directives to subordinate units.

3. Indicate on the 1:50,000 SITMAP overlay the location of the following:
    a. BDE lateral and rear boundaries
    b. BDE coordinating points
    c. Visualized FDA battalion location
    d. Reserve force location
    e. Visualized allowable enemy battalion penetrations, and
    f. Division directed blocking positions

4. You will have one hour to complete the above task, please contact your aide via the telephone (7R) at that time.

RESPONSE SHEET #2

EC-D3
20 Mech Div
West Germany
150200SEP74

TASK ORGANIZATION

    List combat and combat support units in the specific task organization, which you want to recommend. Specify allocation of <u>mech. bns</u>, <u>armd bns</u>, <u>artillery</u>, <u>air defense artillery</u>, <u>armd cav. squadron</u>, and <u>engineers</u>. Cross-attach companies if you wish to.

        1st Bde   2nd Bde

_____   _____

_____   _____

_____   _____

_____   _____

_____   _____

_____   _____

        3d Bde

_____

_____

_____

_____

_____

_____

Div Troop	Div Arty
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	
_____	
_____	
_____	
_____	
_____	
_____	
_____	
_____	

EXHIBIT 8   EC-D3
RESPONSE SHEET #3   150200SEP74

CONCEPT OF MANEUVER AND MISSIONS TO SUBORDINATE UNITS

Write out your recommended concept of the operation and your mission
directives to 20 Mech Div subordinate units under Paragraph 3, below. Each
subparagraph is preceded with a set of instructions. Please follow these
instructions in completing your responses.

1.   SITUATION

     a.   Enemy Forces. Annex A, Intelligence

     b.   Friendly Forces.

          (1) 3d Corps defends immediately in sector with 57 Mech Div on the
               north, 20th Mech Div in the center, and 74th Mech Div on the
               south. 56th Armd Div and 26th (UK) Armd Div are Corps Reserve.

          (2) Elements of 9th TAF support 3d Corps.

          (3) 61st Arty Gp GSR 20th Mech Div.

2.   MISSION

     Division defends in sector immediately from (QA0086) to (Q.10874); allows
     no penetration west of Hills 715 (PA8678), 794(PA8873), and 726(PA9066);
     and concurrently occupies general outpost.

3.   EXECUTION

     a.   Concept of the Operation

          The concept of operation is divided into two subparagraphs: one
          describing the scheme of maneuver and the second covering the plan
          of fire support.

          The first subparagraph gives the concept of operation. This is a
          statement of the commander's tactical plan, to include the scheme of
          maneuver and plan of fire support. It is informative rather than
          directive. It may also provide the commander's visualization of the
          conduct of the operation and a clarification of its purpose. Although
          brief, it is stated in sufficient detail to insure appropriate action
          by subordinates in the absence of additional specific instruction.
          If the operation is phased, each paragraph should reflect same. The
          scheme of maneuver covers employment of major maneuver units and is
          derived primarily from the commander's decision.

A-17

(1) Maneuver

_____
_____
_____
_____
_____
_____
_____

The plan of fire support in the second subparagraph stems from the commander's decision and from staff planning. It includes whether a preparation is to be fired and, if so, its duration and priority of fires.

(2) Fires

_____
_____
_____
_____
_____
_____
_____

In the next subparagraphs, give the specific task to be accomplished by each of the major elements of the command.

(3) 1 Bde:

_____

_____

_____

_____

_____

_____

(4) 2 Bde:

_____

_____

_____

_____

_____

_____

(5) 3 Bde:

_____

_____

_____

_____

_____

_____

(6) Artillery. The artillery subparagraph is divided into two parts: the
    first covers field artillery and the second covers air defense artillery.
    In listing artillery, the organic and attached units are listed in num-
    erical sequence (regimental numbers), beginning with the lowest numbered
    unit. As minimum, the artillery subparagraph includes the artillery
    organization for combat.

    (a) FA:

    _____

    _____

    _____

    _____

    _____

    _____

    _____

    _____

    (b) ADA:

    _____

    _____

    _____

    _____

    _____

    _____

    _____

    _____

(7) Other Combat Elements. Other elements providing combat support (e.g.,
     armored carrier units or engineer units performing combat support engineer
     tasks, as applicable). These elements are listed in alphabetical sequence
     by branch. Normal service missions are not included. It is not necessary
     to list all the units in the command, nor is it required to give in-
     structions for the total employment of a particular unit. For example,
     instructions to an engineer unit concern only the combat support portion
     of the unit's mission.

     (a) Engr:

     _____

     _____

     _____

     _____

     _____

     _____

     _____

     (b) Reserve:

     _____

     _____

     _____

     _____

     _____

     _____

     _____

     _____

(8) Coordinating Instructions. The last subparagraph of paragraph 3 is
    entitled "Coordinating Instructions" and contains details of coordination
    and control applicable to two or more elements of the command. Troop
    safety measures appropriate to the nuclear battlefield may be shown here.
    Restrictions on use of nuclear weapons may be included. Priorities and
    necessary coordination for use of the airspace above the battlefield are
    shown here.

_____

_____

_____

_____

_____

_____

EXHIBIT 9
DEFENSIVE SCENARIO

COMBAT SESSION BRIEFING

SITUATION

a. You are asked to continue in the role of G-3 of the 20th Inf Div
(Mech).

b. The Division Commander has considered all defensive planning recom-
mendations. The resulting 20 Mech Div OPLAN 37 was approved by 3d
Corps. Therefore, your assignment is to execute 20 Mech Div OPORD
37, a copy of which is attached.

c. All units have now moved to defensive positions, as portrayed on
the operations Overlay for OPORD 37.

YOUR TASKS

In keeping with the mission of the 20th Div you are to do everything you
can to delay the aggressor and to defend your sector.

You have already organized your forces and positioned them for the defense.
when combat starts you will be advised every ten minutes of developments. You
will be able to follow specific situations if you establish Standing Requests
for Information (SRI). If some of your units are in trouble, you may wish to
reinforce them by cross-attachments, at the company and battalion levels, by
calling in tactical air strikes, or by requesting artillery support. You may
also access the data base, as you did earlier, in order to extract particular
items of information.

We realize that a Division G-3 would not be expected to perform some of
the tasks that we will ask you to do this afternoon. These tasks will include
calling in artillery fires and air strikes to support your maneuver units,
normally a fire support coordinator function. However, we need to know **when**
such support would be given and **how much** support would realistically be given.
Based on the responses given by persons such as yourself, we shall be able to
program the computer to handle the fire support and tac air requirements in a
realistic manner, so that future consultants can proceed with their normal
decision making tasks.

The computer will not "know" when and how to use the simulated fire
power unless we tell it. We prefer that such judgments be based on data
provided by experienced military officers such as yourself.

Your specific goals are to hold terrain, inflict maximum personnel and
materiel losses on the enemy, and minimize such losses for your forces.

4. TASK ORGANIZATION AND MISSIONS

At the start of combat, all maneuver and support units will be organized and will receive initial mission directives in accordance with 20 Inf Div OPORD 37. Further commands to these units or to specific artillery and air units will be initiated by you, using the CRT.

5. TIME

After you have been instructed in how to operate the CRT keyboard the exercise will begin. The exercise start time/date will be 151240SEP. The start of the exercise will be signalled by the general index automatically appearing on your CRT.

EXHIBIT 10

(CLASSIFICATION)
(No change from verbal orders)

EC-D3
Copy 2 of 12 copies
20 MECH DIV
CULMITZ (011159) GERMANY
150300SEP74

OPORD 37

REFERENCE: A - Map, (Germany 1:50,000, HOF - PLAUEN)

B - Map (Central Germany - 1:250,000)

C - Overlay (20 Mech Div Area of Operations)

TASK ORGANIZATION

1st Bde

    1-66 Mech
    1-67 Mech
    1-68 Mech
    1-1 Armd
    1-45 FA(DS)
    B/1-439 ADA
    A/20 Engr (DS)

2d Bde

    1-69 Mech
    1-70 Mech
    1-71 Mech
    1-2 Armd
    1-46 FA(DS)
    B/20 Engr (DS)

3d Bde

    1-72 Mech
    1-3 Armor
    1-21 Cav
    1-47 FA Bn-Grp
      1-47 FA
      2-631 FA (155-SP)(remains attached)
    A/1-439
    C/20 Engr (DS)

DIV TRP

    20 Engr (-)
    20 AVN
    20 SIG
    20 MI Co

DISCOM

    20 Admin Co
    20 Maint
    20 Med
    20 S&T

DIVARTY

    1-48 FA
    1-49 FA
    1-439 ADA (-)

(CLASSIFICATION)

(CLASSIFICATION

1. SITUATION

    a. Enemy Forces

        (1) The Agressor 16 Combined Army is expected to attack through the Hof Gap with probable objective to secure the rail heads vic COBURG (PA4070).

        (2) Concentrations of enemy forces suggest that main attack may occur in 20 Mech Div sector along Avenue of Approach (Alpha). See overlay.

        (3) Secondary attacks can be expected along Avenues of Approach (Bravo), (Charlie), and (Delta). See overlay.

        (4) Enemy units opposing 20 Mech Div are approximately 95 percent TO/E.

        (5) Annex A (Intelligence).

    b. Friendly Forces

        (1) 3d (US) Corps prepares to conduct mobile defense in sector NLT 150400SEP with 57 Mech Div in the north, 20 Mech Div in the center, and 74 Mech Div in the south. 56 Armd Div is Corps reserve with priority of employment to 74 Mech Div. 401st Arty Gp protects in priority Corps: FDA, Corps reserve, corps command post.

        (2) 26 (UK) Armd Div supports 3d (US) Corps.

        (3) Elements of 9th Tactical Air Force support 3d (US) Corps.

        (4) 61st FA Grp GSR 20th Mech Div.

    c. Attachments and Detachments. Task Organization

2. MISSION

    20 Mech Div defends NLT 150400SEP from (120270) to (200120), retains Hills 715 (PA8678), 794 (PA8873) and 726 (PA9066) and delays Agressor east of the Saale River (190180)FEBA for 24 hours.

3. EXECUTION

    a. Concept of Operation (Annex B Operation overlays)

        (1) Maneuver. 20th Mech Div conducts area defense of the Saale River from (115275) to (200130). 1st Bde defends in the north. 2d Bde defends in the south. 3d Bde, div res, prepared to counterattack to restore the FDA, priority to sector of 1st Bde. 3d Bde establishes div GOP of two battalions to obtain 24-hour delay.

(CLASSIFICATION)

A-26

(CLASSIFICATION)

    (2) Fires. Priority of artillery and close air support first to the GOP, to the 1st Bde upon withdrawal of the GOP, to the div res when commited.

b. 1st Bde:

    (1) Defends in Sector

    (2) Prepare in priority: blocking position 1, 2, and 3.

c. 2nd Bde:

    (1) Defends in Sector

    (2) Prepares in priority: blocking positions 4, 5, 6.

d. 3d Bde:

    (1) Establishes GOP immediately with two battalion-sized task force; delays enemy forward of FEBA for 24 hours.

e. ARTY:

    (1) FA:

        (a) 1-45 FA: DS 1st Bde

        (b) 1-46 FA: DS 2d Bde

        (c) 1-47 FA: Form 1-47 FA Bn-Gp; after group ceases GSR 1-46 FA; DS 3d Bde on commitment.

        (d) 1-47 FA Bn-Gp:
           1-47 FA
           2-631 FA
        Attached 3d Bde; attachment and Bn-Gp cease on withdrawal of GOP.

        (e) 1-48 FA: GSR 1-47 FA Bn-Gp; on withdrawal GOP, GSR 1-45 FA

        (f) 1-49 FA: GS

        (g) 2-631 FA Atch 1-47 FA Bn-Gp; after group ceases GSR 1-46 FA

    (2) ADA:

        (a) 1-439 ADA (-): Protect in priority: division reserve, division command post, DISCOM.

        (b) A-439 ADA: atchd 3d Bde; on withdrawal of GOP; atchd 2d Bde

        (c) B/1-439 ADA: atchd 1st Bde

    (3) Annex C, Fire Support.

(CLASSIFICATION)

(CLASSIFICATION)

    f. <u>20 Mech Div Aviation:</u> GS; support 3d Bde with A.20 Avn until withdrawal GOP

    g. <u>20 Mech Div Engr:</u> (-): GS; priority to the reserve. On withdrawal GOP, C/20 Engr: DS 3d Bde

        (1) 20 Engr

        (2) Annex D (Engineer)

    h. <u>Reserve:</u> (-)

        (1) Battalion Task Force of 3d Bde until withdrawal of GOP.

        (2) 3d Bde after withdrawal through FEBA.

        (3) Prepares to execute Div counterattacks, priority to 1st Bde sector.

        (4) Prepare to release one company for rear area security.

    i. <u>Coordinating Instructions:</u>

        (1) Bdes in FDA support GOP withdrawal.

        (2) 1st and 2d Bdes destroy Saale River Bridges in sector upon withdrawal of GOP.

        (3) Priority of road movement to GOP force on withdrawal through sector.

4. <u>SERVICE SUPPORT:</u> ANNEX E

    DISCOM operational in vicinity SCHWARZENBACK (PA8774) NLT 150100SEP.

5. <u>COMMAND AND SIGNAL:</u> ANNEX F

    Div CP opens in vicinity of CULMITZ (011159) 150300SEP.

ACKNOWLEDGE   Smith
                                                          MG

OFFICIAL:

Jones
G3

Annexes A - Intelligence (omitted)
        B - Operation Overlays

EXHIBIT 11

TROOP LIST AND CODE INDEX

EC-D5

1ST BDE

UNIT	CODE	WPN
1-66 Mech Bn	703	
A/1-66	704	
B/1-66	705	
C/1-66	706	
1-67 Mech Bn	712	
A/1-67	713	
B/1-67	714	
C/1-67	715	
1-68 Mech Bn	716	
A/1-68	717	
B/1-68	718	
C/1-68	719	
1-1 Armd Bn	707	
A/1-1	708	
B/1-1	709	
C/1-1	710	
1/45 Arty	747	155MM(SP)
A/1-45	748	155MM(SP)
B/1-45	749	155MM(SP)
C/1-45	750	155MM(SP)

2D BDE

UNIT	CODE	WPN
1-69 Mech Bn	720	
A/1-69	721	
B/1-69	722	
C/1-69	723	
1-70 Mech Bn	733	
A/1-70	734	
B/1-70	735	
C/1-70	736	
1-71 Mech Bn	737	
A/1-71	738	
B/1-71	739	
C/1-71	740	
1/2 Armd Bn	724	
A/1-2	725	
B/1-2	726	
C/1-2	727	
1-46 Arty	751	155MM(SF)
A/1-46	752	155MM(SP)
B/1-46	753	155MM(SP)
C/1-46	754	155MM(SP)

3D BDE

UNIT	CODE	WPN
1-72 Mech Bn	741	
A/1-72	742	
B/1-72	743	
C/1-72	744	
1/49 Arty	763	HJ MSL
A/1-49	764	HJ MSL
B/1-49	765	HJ MSL

TROOP LIST AND CODE INDEX

UNIT	CODE	WPN
GOP FORCE		
1-3 Armd Bn	728	
A/1-3	729	
B/1-3	730	
C/1-3	731	
1-47 Arty	755	155MM(SP)
A/1-47	756	155MM(SP)
B/1-47	757	155MM(SP)
C/1-47	758	155MM(SP)
2-631 Arty	766	155MM(SP)
A/2-631	767	155MM(SP)
B/2-631	768	155MM(SP)
C/2-631	769	155MM(SP)
1-48 Arty	759	8 inch
A/1-48	760	8 inch
B/1-48	761	8 inch
C/1-48	762	8 inch
1/21 ACS	795	
A/1-21	796	
B/1-21	797	
C/1-21	798	
C/1-21	799	

UNIT	CODE	WPN
DIVARTY		
1-439 Arty	800	C/V
A/1-439	801	VULCAN
B/1-439	802	VULCAN
C/1-439	803	CHAPARRAL
D/1-439	804	CHAPARRAL
61 ARTY GROUP		
1-61 Arty	811	HJ MSL
A/1-61	812	HJ MSL
B/1-61	813	HJ MSL
2/61 Arty	714	155MM(SP)
A/2-61	715	155MM(SP)
B/2-61	716	155MM(SP)
C/2-61	717	155MM(SP)
3/61 Arty	818	155MM(SP)
A/3-61	819	155MM(SP)
B/3-61	820	155MM(SP)
C/3-61	821	155MM(SP)
4/61 Arty	822	8 inch
A/4-61	823	8 inch
B/4-61	824	8 inch
C/4-61	825	8 inch
5-61 Arty	826	8 inch
A/5-61	827	8 inch
B/5-61	828	8 inch
C/5-61	829	8 inch

UNIT	WPN	CODE
54 ENGR		
1-54 Engr Bn		831
A/1-54		832
B/1-54		833
C/1-54		834
D/1-54		835
HQ		
20 Engr Bn		778
A/20		779
B/20		780
C/20		781
D/20		782
E/20		783
129 AVN		849
Aslt Co.		850
Gen Spt Co.		851
TAC AIR SQDN 15		852
Flt A		853
Flt B		854
Flt C		855

EXHIBIT 13

DECISION AIDED SIMTOS

Thank you for your participation as a consultant in this effort to develop automated decision support systems for Army Officers. We know that it has been a strenuous day, but we would appreciate a few more minutes of your time. Your answer to the following questions can help us refine our research and fulfill our objective of producing military information systems that are responsive to your needs. This information, as well as the rest of today's materials, is confidential.

Personal Data

Name _____ Present Rank _____

Age _____ Years of Active Military Service _____

Present Position _____

Military Experience

1. Please summarize your military experience in chronological order in the spaces provided. Please emphasize any previous G-3 experience.

YEAR	UNIT (Co. Bn. Div.)	TYPE (Inf. Mech. Armd)	POSITION HELD (Co.G-3, etc)	DURATION (Months)	LOCATION (Country)	COMBAT (Months)

2. If you have ever participated in ATT, CPX, FTX or Map exercises in West Germany, please fill in the following blanks. If you have never participated in these activities, continue to the next question.

YEAR	UNIT (Co., Bn., Div.)	POSITION (Cmdr. X-O, Etc.)	Type and Number of Exercises
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

Education

3. Please indicate (V) whether you have attended any of the following Army Schools. If you have, please fill in the supplementary blanks.

    a) U. S. Army Command and General Staff College

       Year Graduated_____

    b) National War College (Ft. McNair)

       Year Graduated_____

    c) Army War College (Carlisle Barracks)

       Year Graduated_____

4. Please circle highest year completed:

    College   1 2 3 4   Degree_____   Field_____

    Graduate 1 2 3 4 5   Degree_____   Field_____

Review of SIMTOS

Please ✓ your response.

5. Were you satisfied with the way you   YES   NO
   were contacted to participate as a
   consultant?

6. Before working on the SIMTOS task, you   YES   NO
   participated in an interview designed
   to assess the characteristics of your
   decision making behavior. The purpose
   of the interview was to provide the
   information necessary to adapt decision
   support systems to your "style"

   Was the interview interesting?

   Please list the scenarios you remember.

   Were any of the scenarios particularly
   challenging?

   Would you participate in such an inter-
   view again?

7. Although SIMTOS is not an operational tactical information system, the
   knowledge being gained from its study will serve as the background for
   the development of future decision support systems.

   With the design of these future systems in mind, how would you rate SIMTOS
   (as you used it today) performance, i.e., how well did it help you accomp-
   lish your mission?

   Fair   1   2   3   4   5   Excellent

   Would you agree or disagree with the following statement: Military
   information systems must be responsive to the information requirements
   and "command style" of the user.

   Agree   Disagree

8. In which of the following functions would you prefer to use an automated
   system instead of a staff officer (please check ✓).

   Intelligence Gathering
   Troop Organization
   Logistical Planning
   Contingency Planning
   Implementation of Orders
   Communication
   Other

Thank you again for participating in the evaluation of decision aided SIMTOS.
We would welcome any further comments on these efforts.

APPENDIX B

DESCRIPTIVE STATISTICS
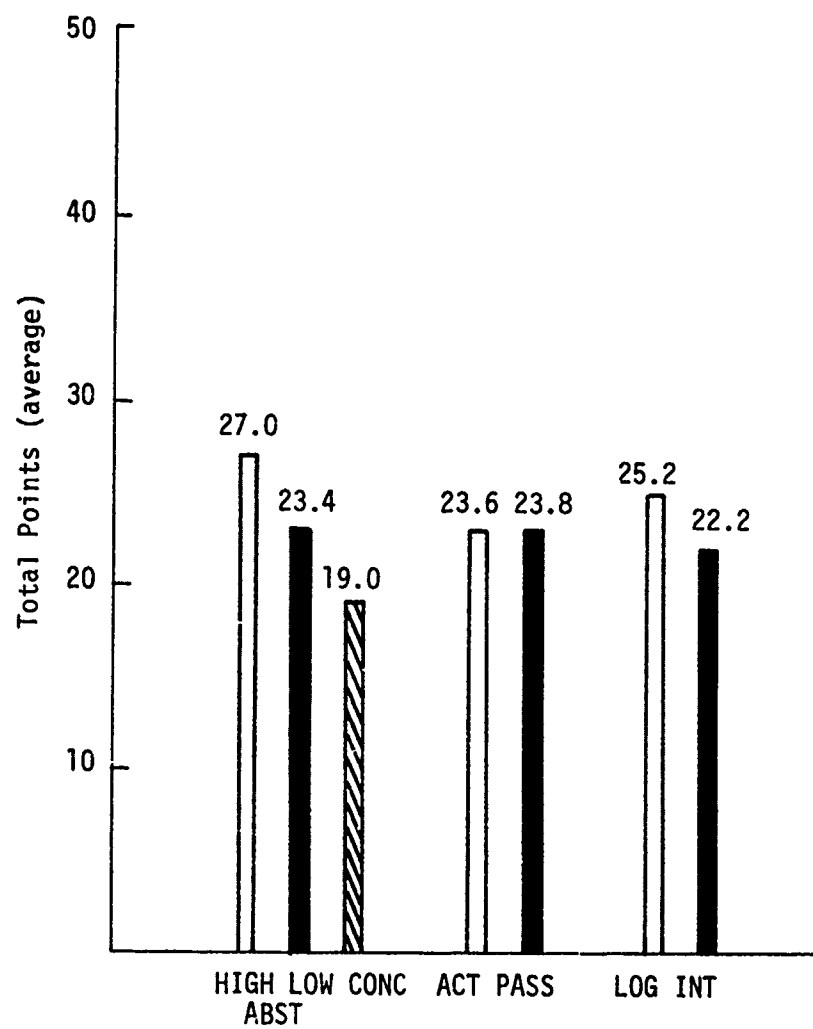
Figure B-1. Planning Scores: Styles
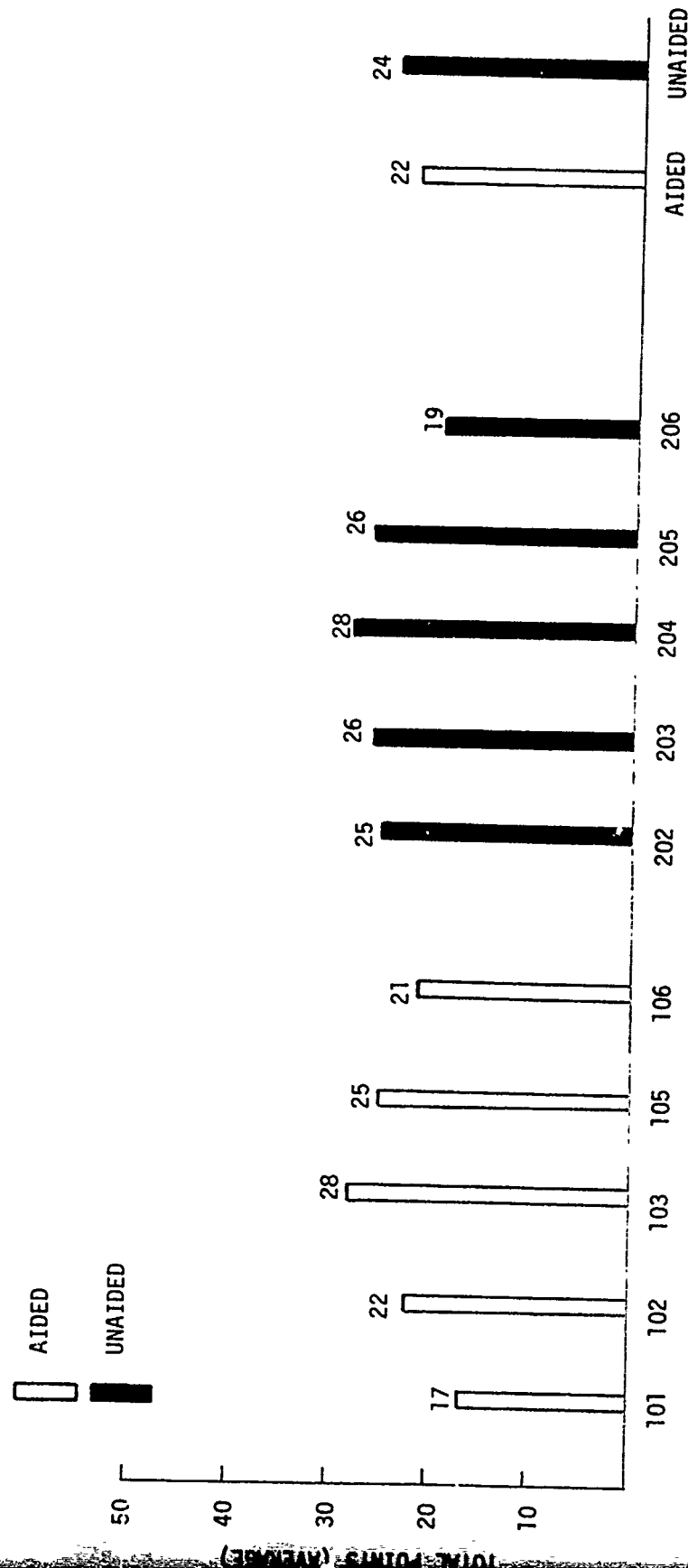
Figure B-2. Planning Scores: Individual Consultant and Aided/Unaided
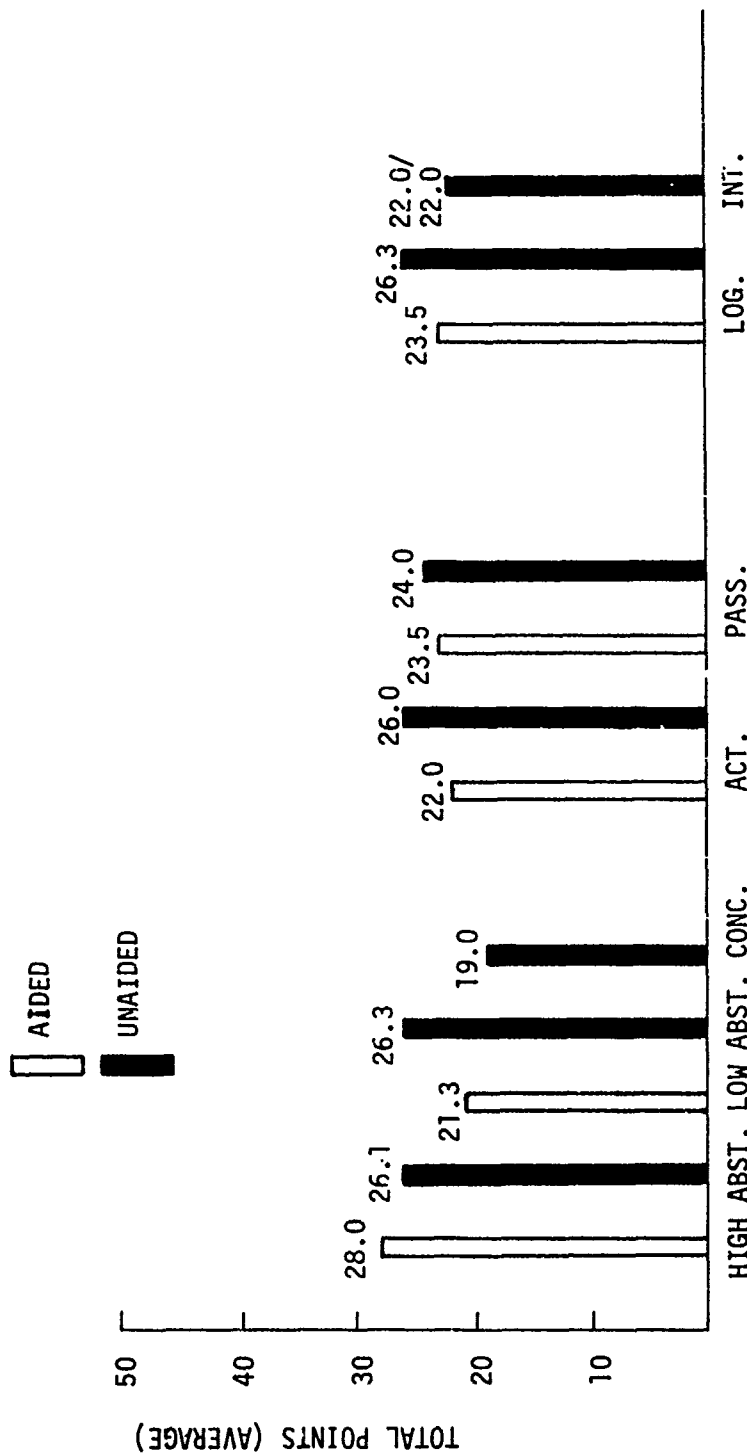
Figure B-3. Planning Scores: Styles (Aided and Unaided)
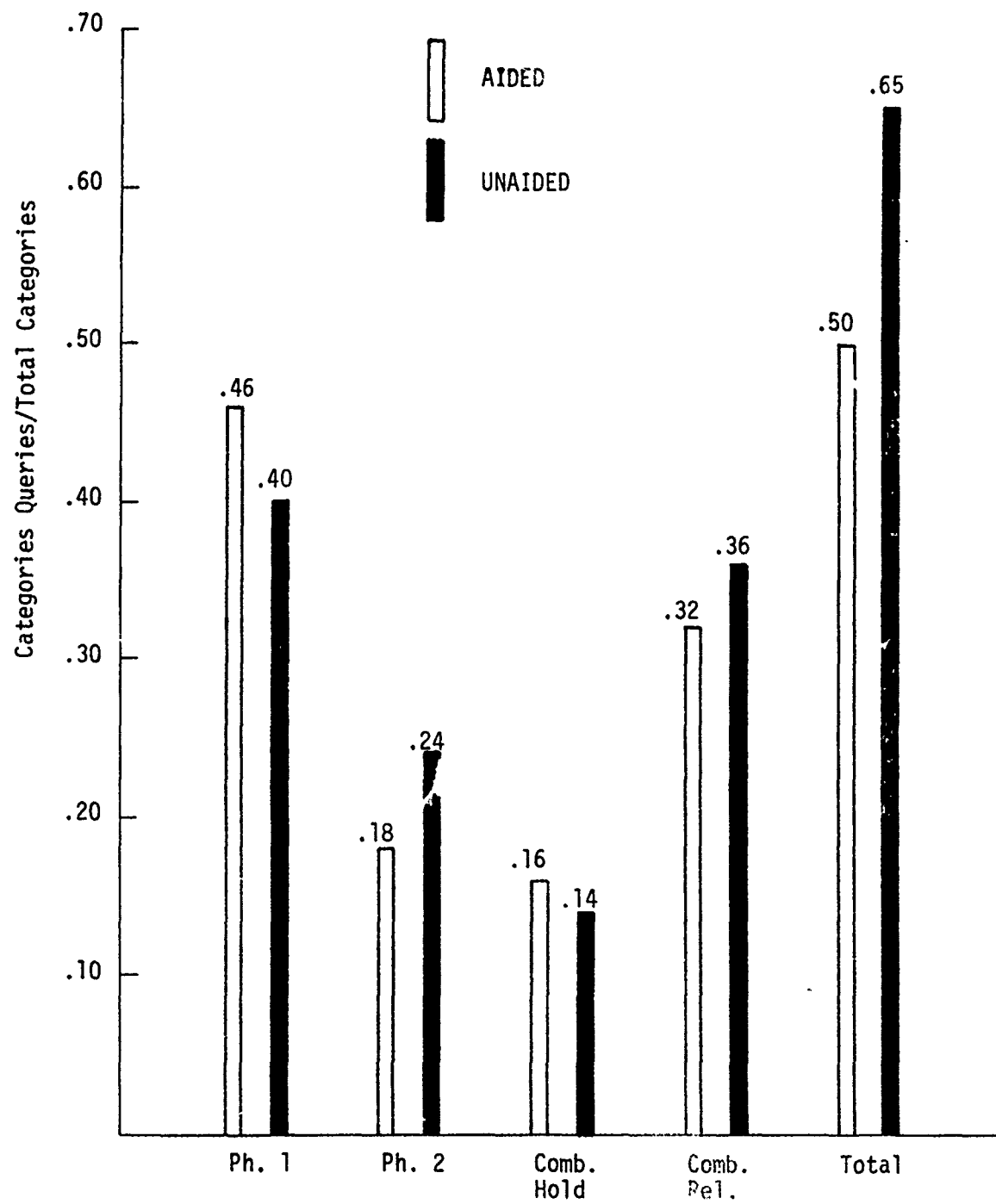
Figure B-4. Sources Sought: Aided/Unaided
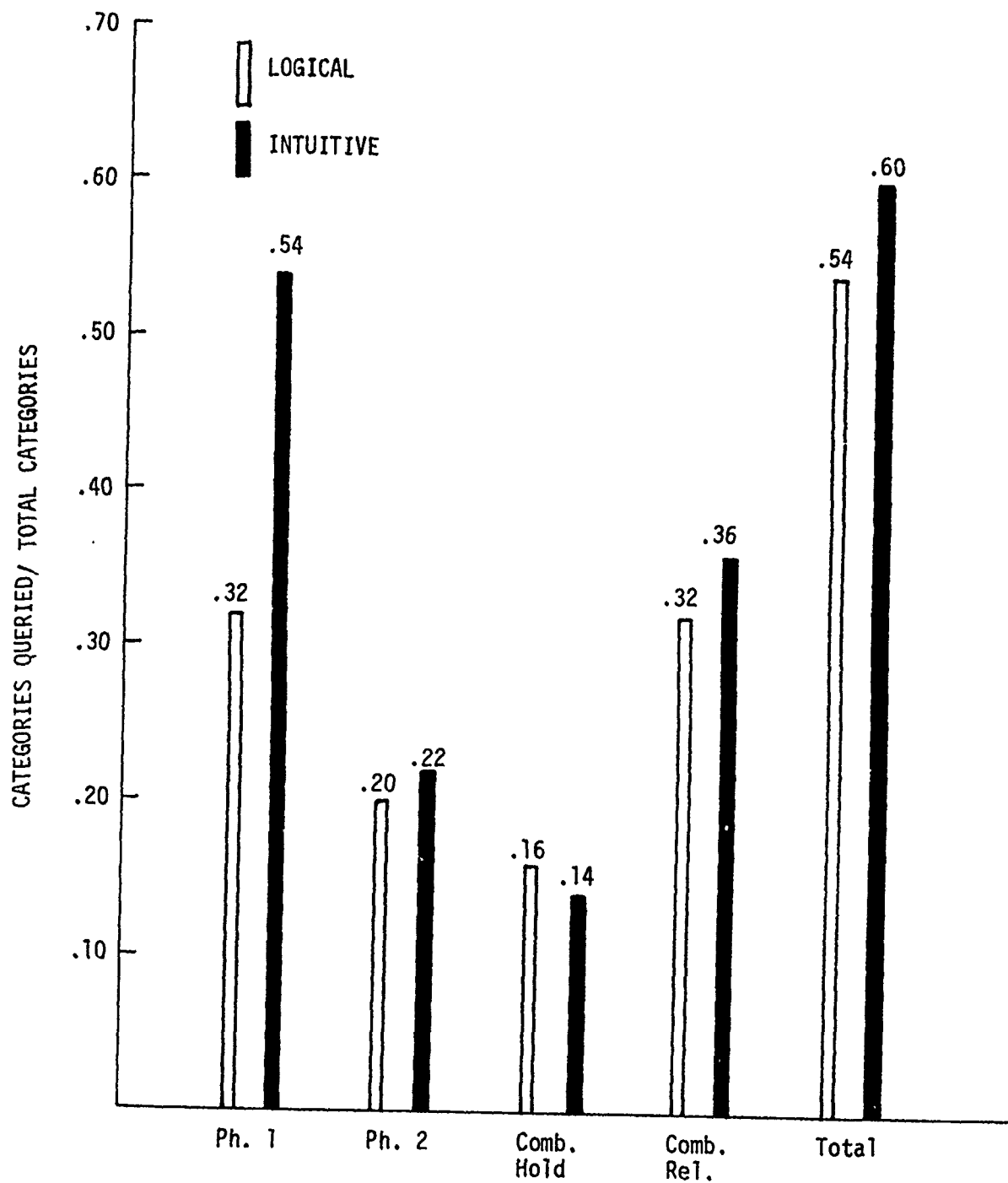
Figure B-5.   Sources Sought: Logical/Intuitive
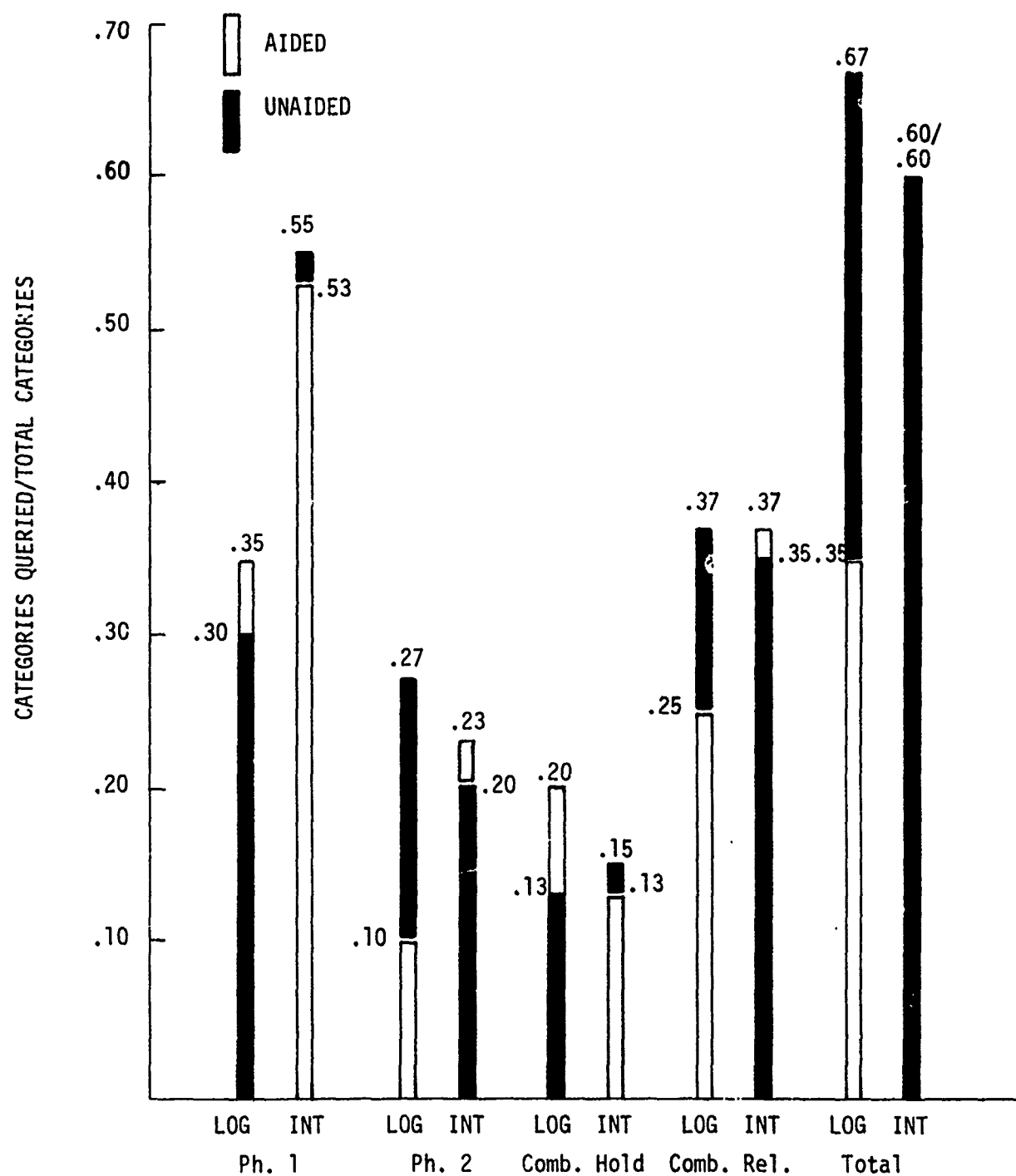
Figure B-6. Sources Sought: Logical/Intuitive (Aided and Unaided)
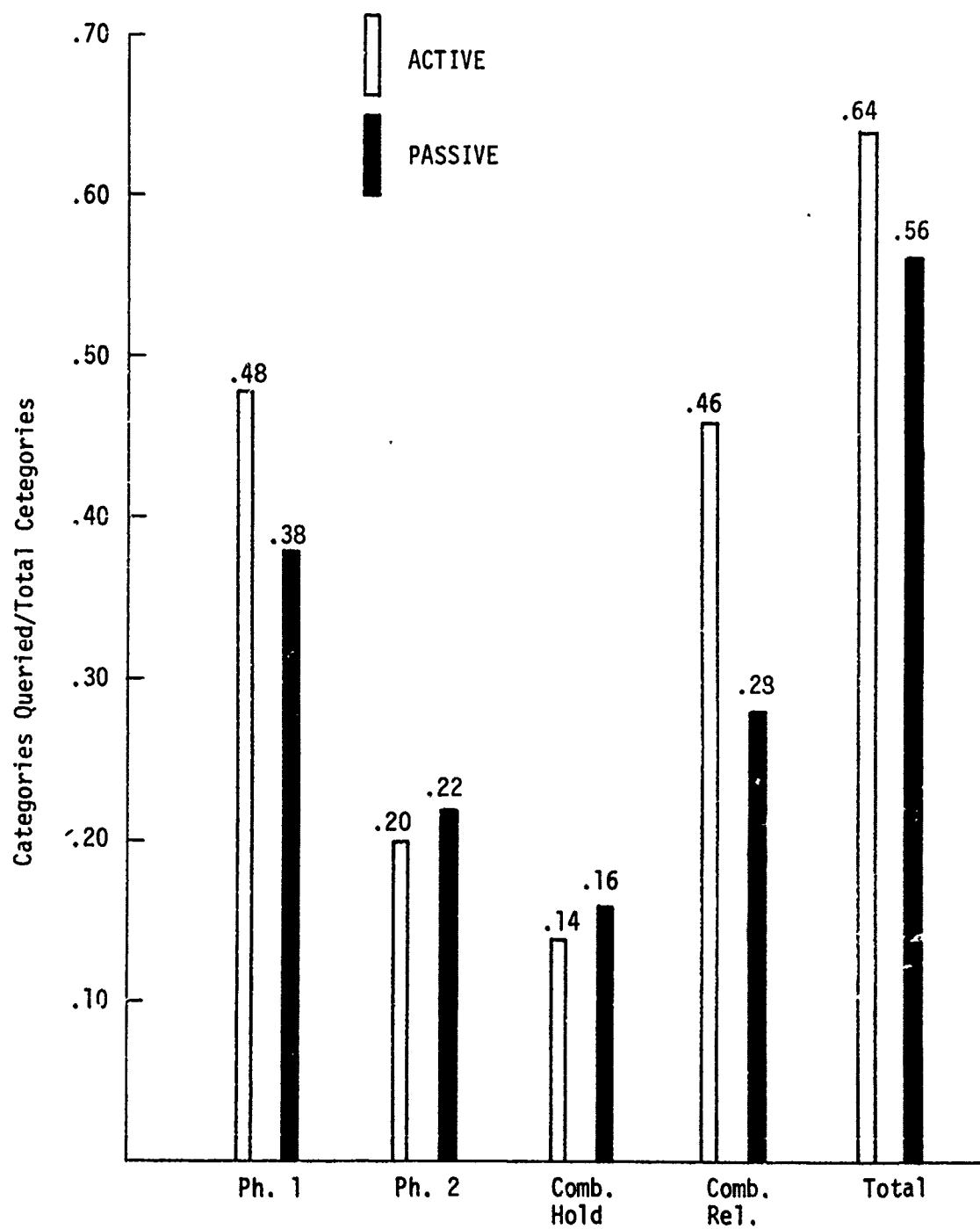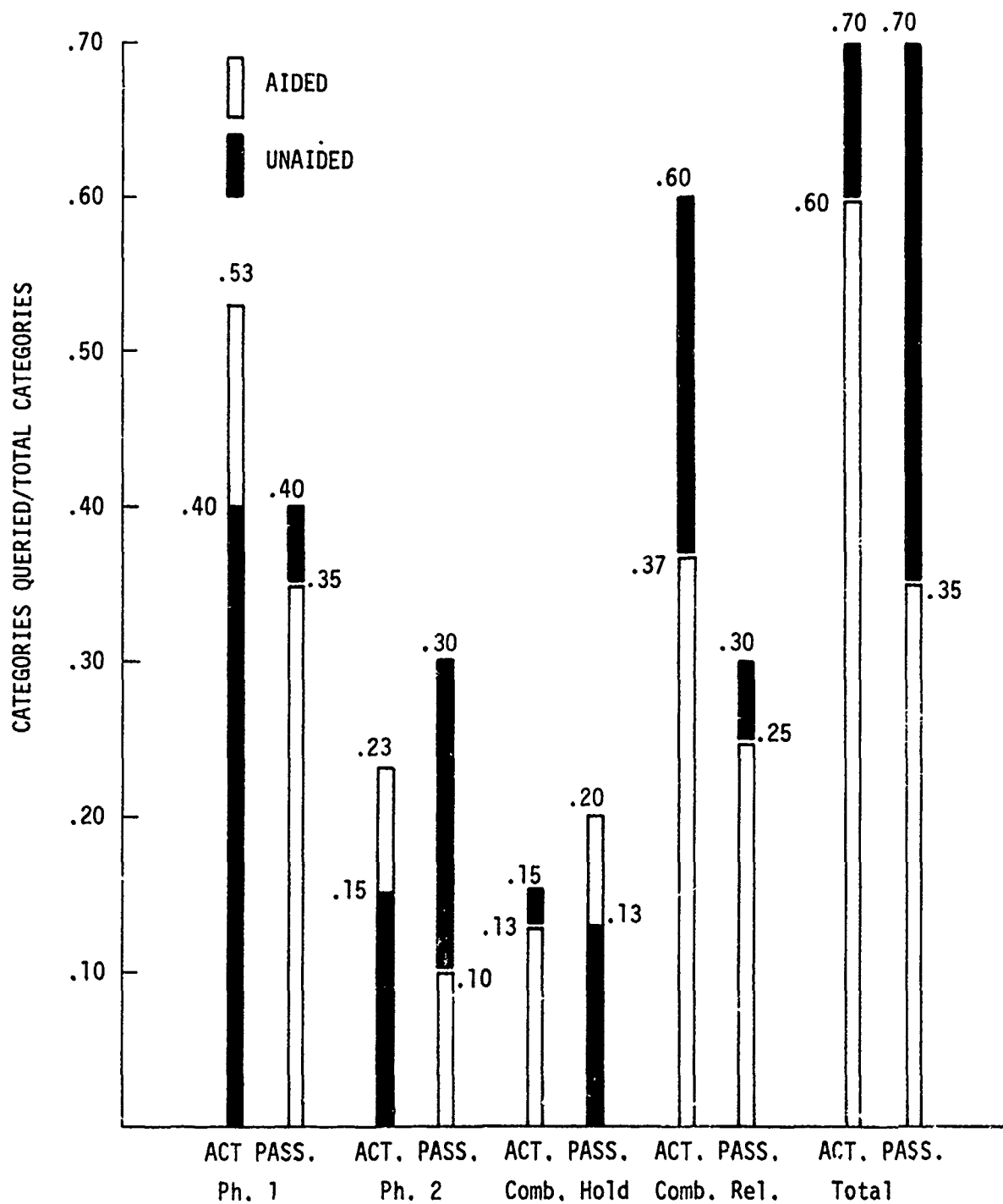
Figure B-8. Sources Sought: Active/Passive (Aided and Unaided)

HIGH ABSTRACT

LOW ABSTRACT

CONCRETE

Categories Queried/Total Categories

.70

.60

.51

.50

.48

.45 .45

.40

.40 .39

.33

.30

.25

.20 .20 .20 .20

.17

.15

.10 .10

Ph. 1   Ph. 2   Comb. Hold   Comb. Rel.   Total
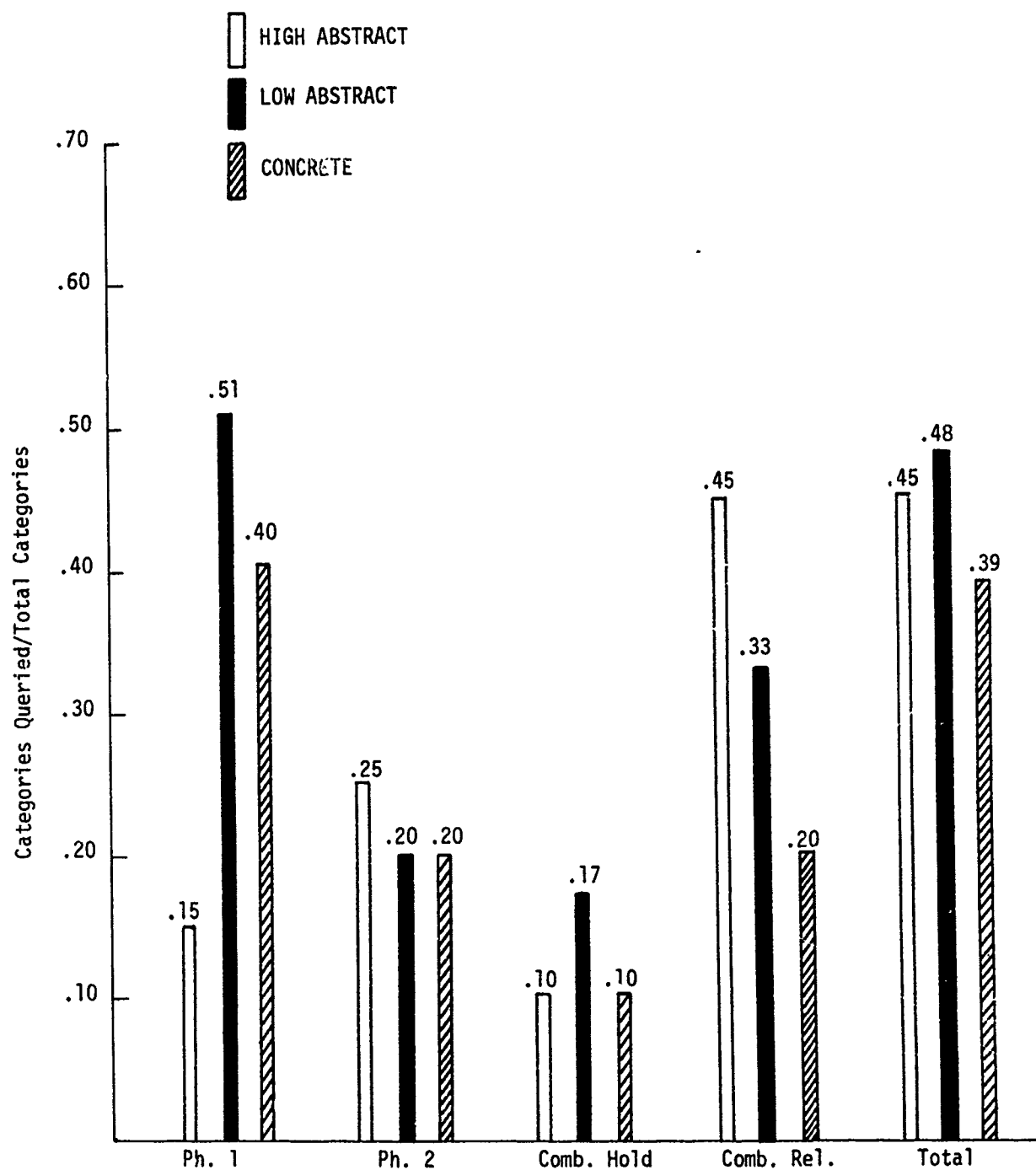
Figure B-9. Sources Sought: High Abstract/Low Abstract/Concrete
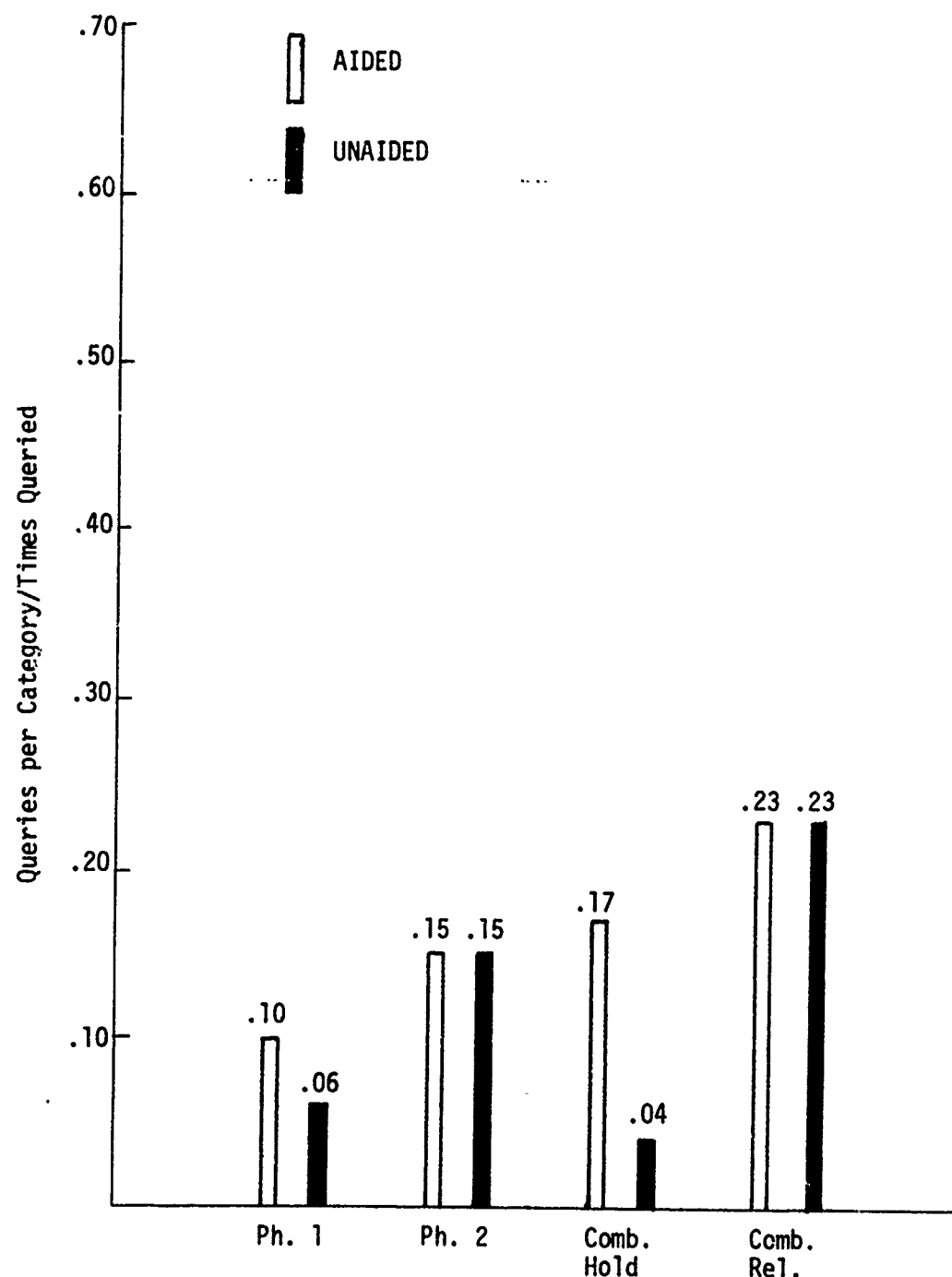
Figure B-10. Action Ratio: Aided/Unaided
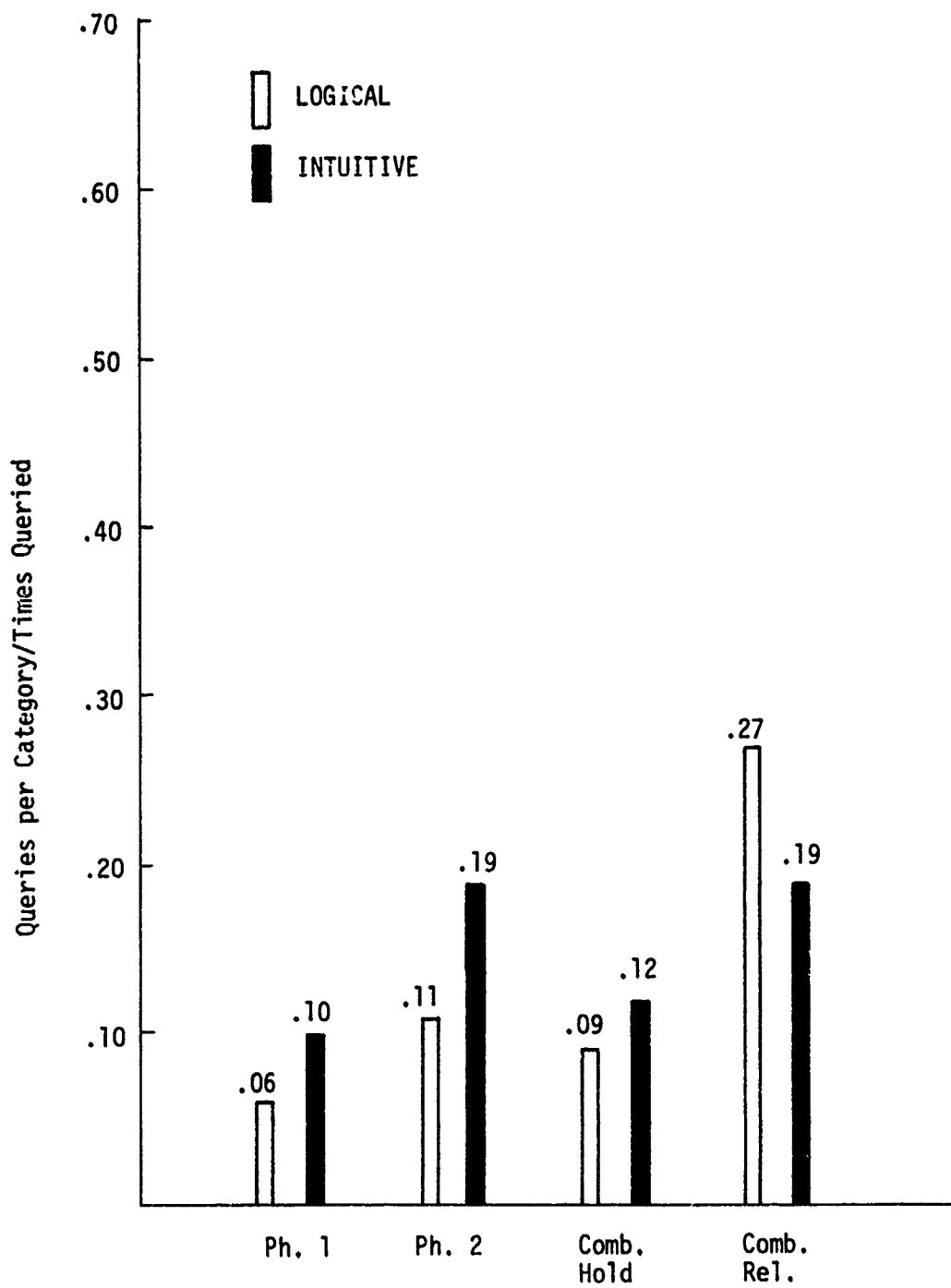
Figure B-11. Action Ratio: Logical/Intuitive
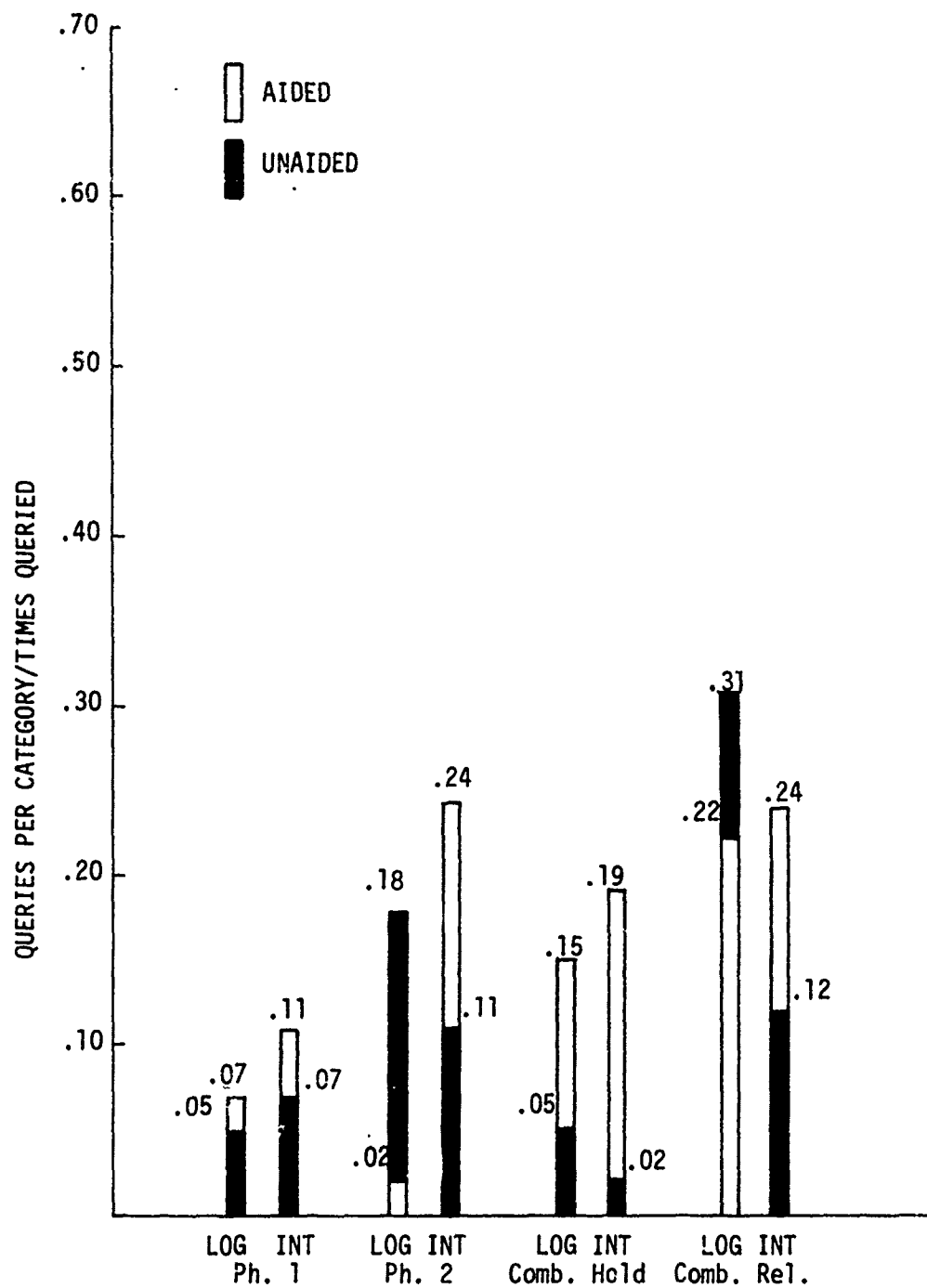
Figure B-12. Action Ratio: Logical/Intuitive (Aided and Unaided)
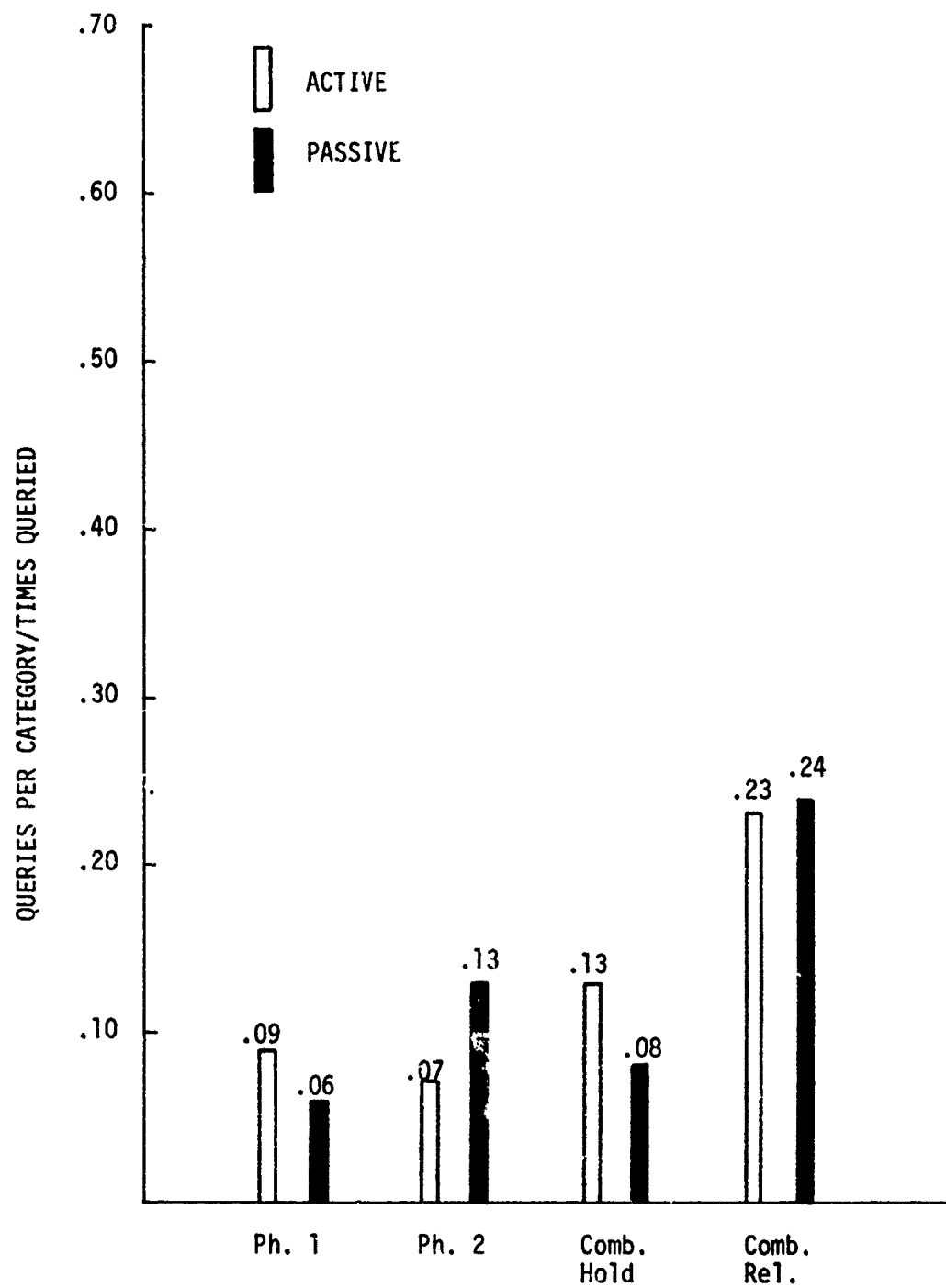
Figure B-13. Action Ratio: Active/Passive
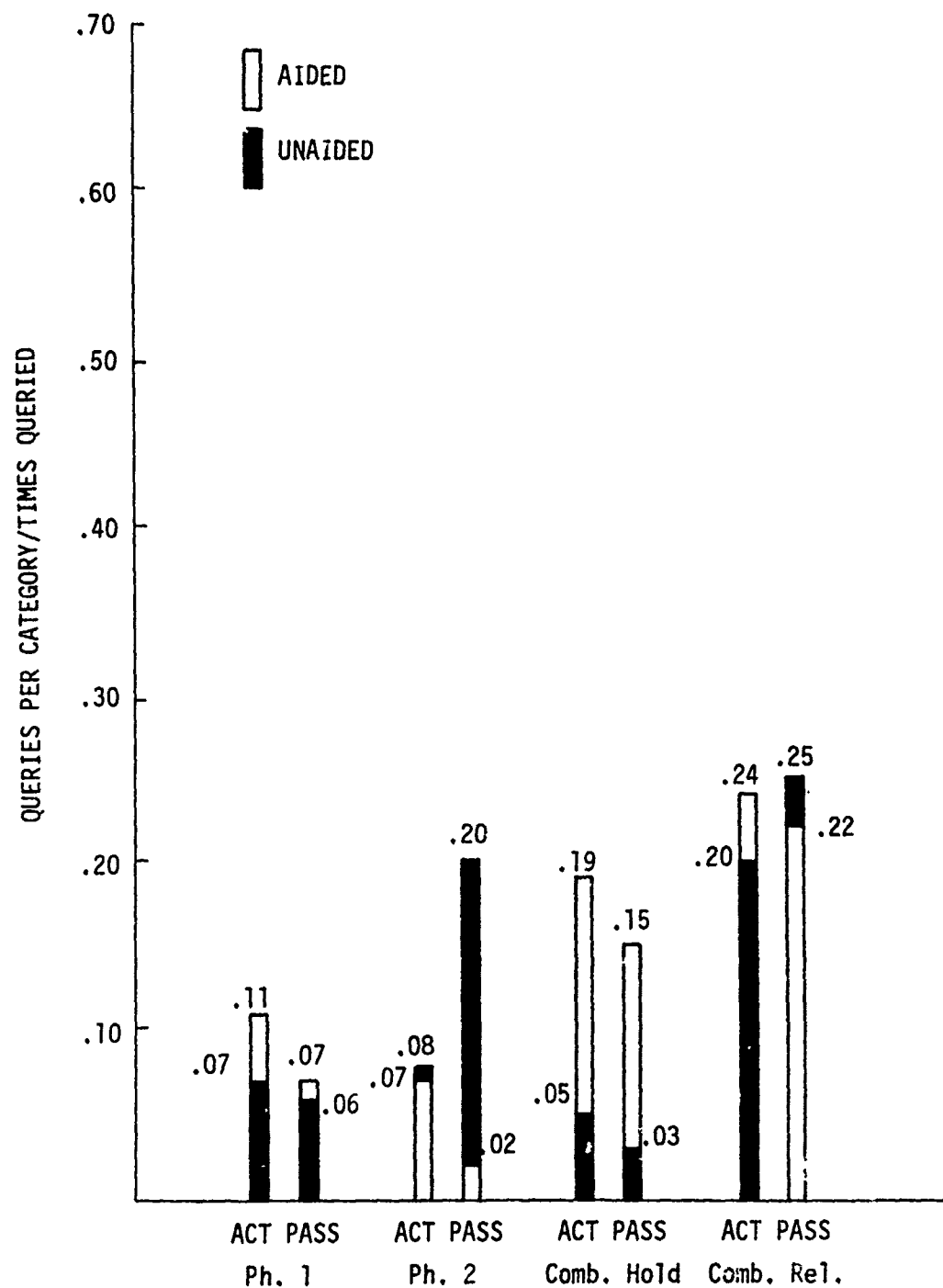
Figure B-14. Action Ratio: Active/Passive (Aided and Unaided)
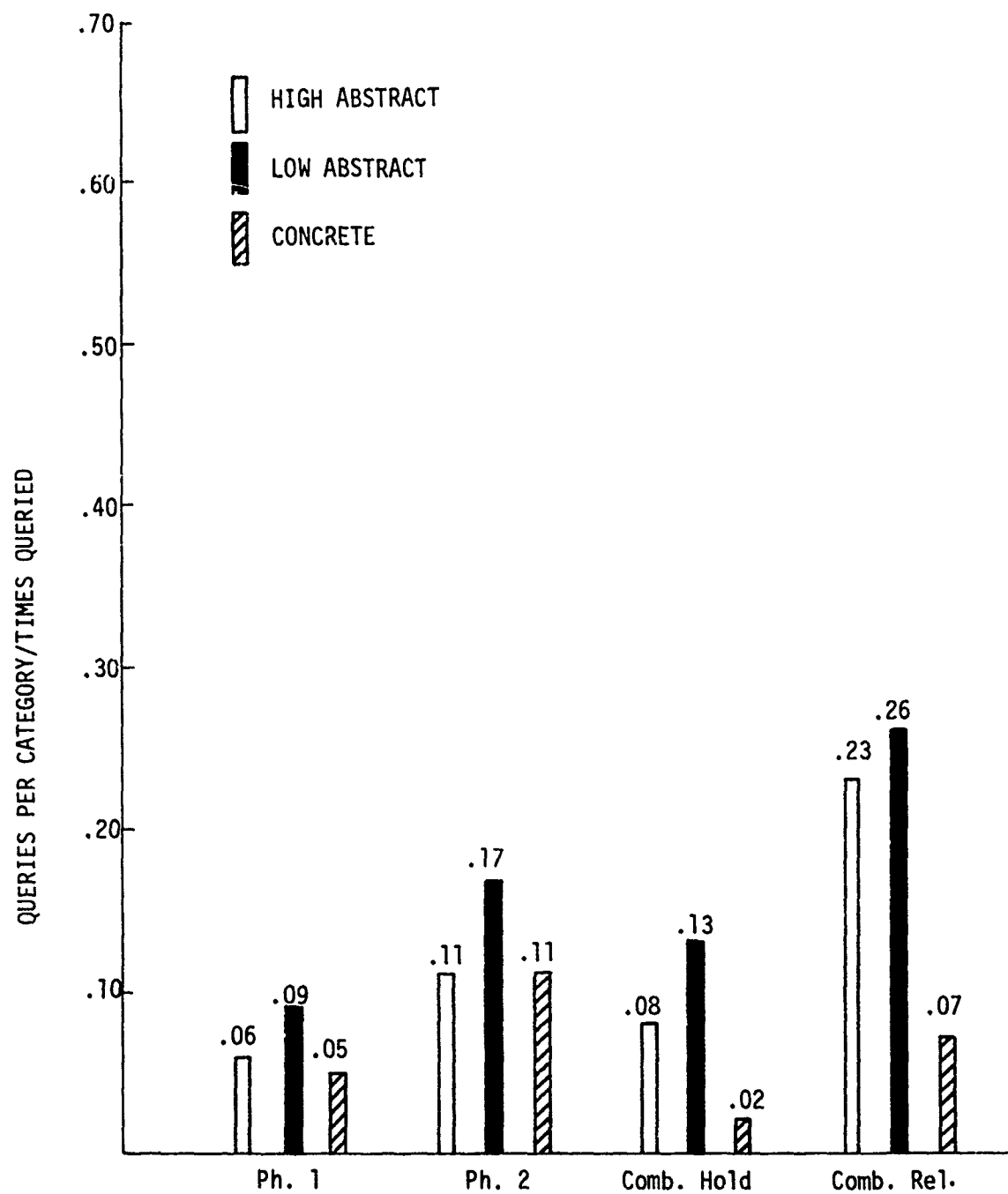
Figure B-15. Action Ratio: High Abstract/Low Abstract/Concrete
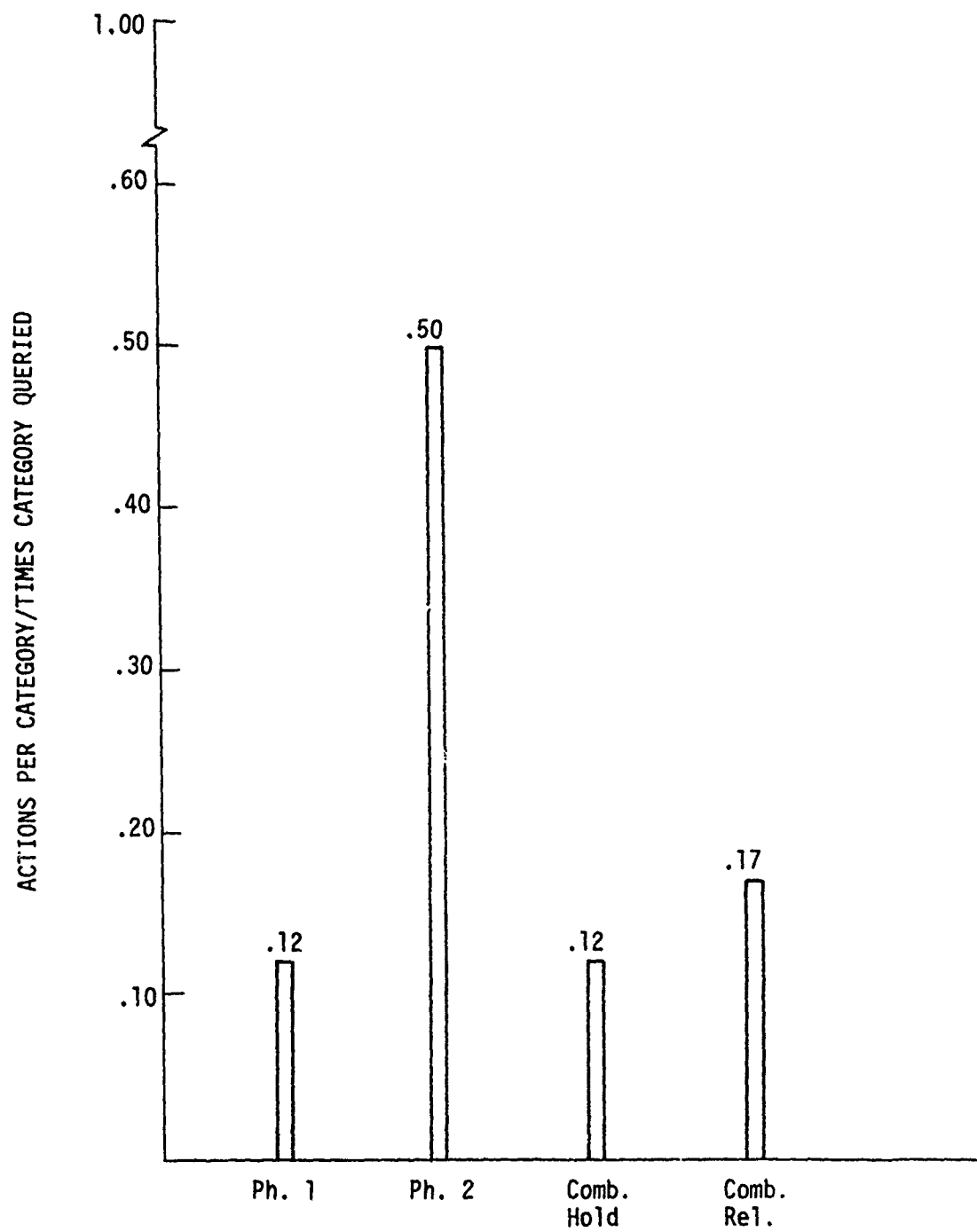
Figure B-16. Action Ratio: C#101
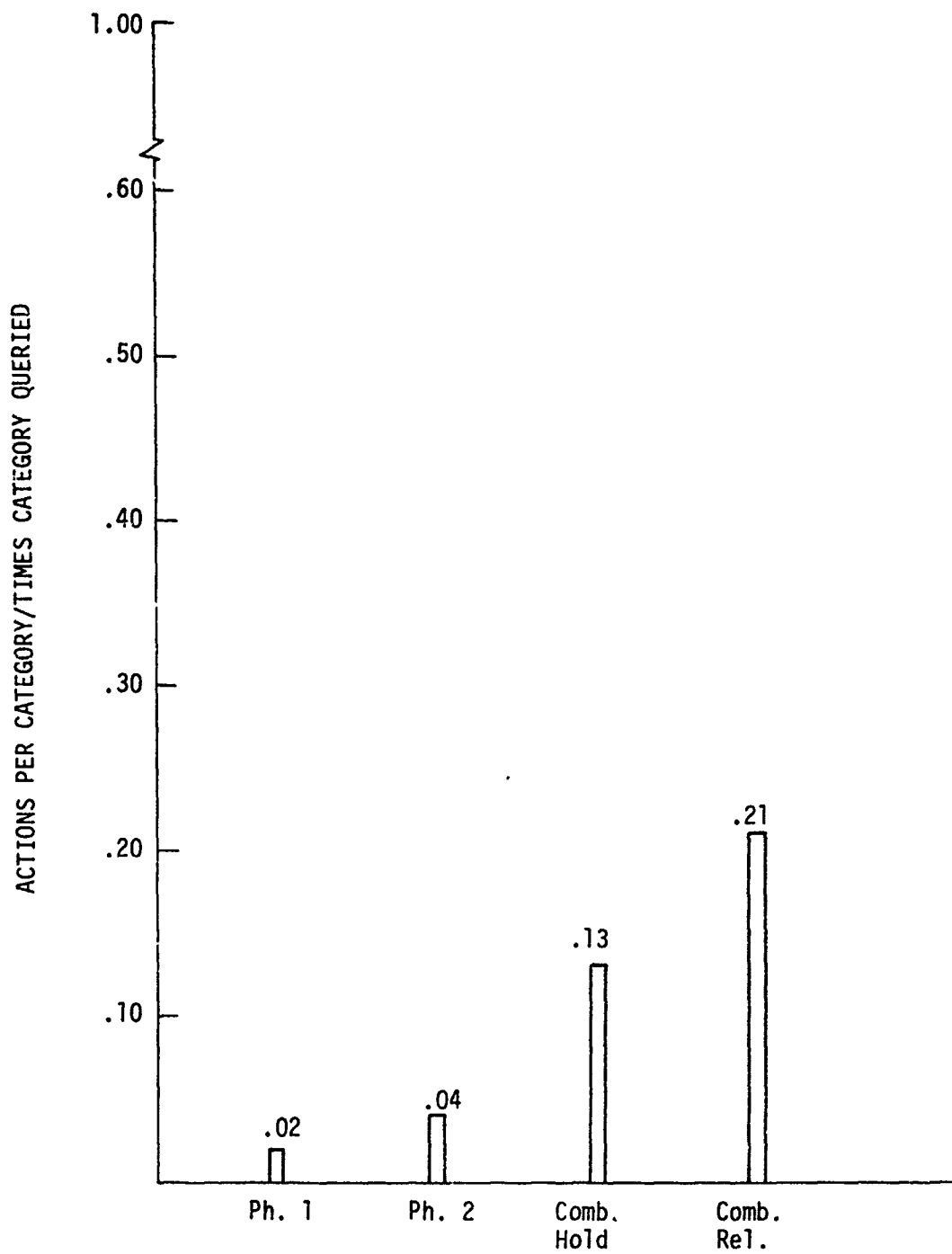
Figure B-17. Action Ratio: C#102
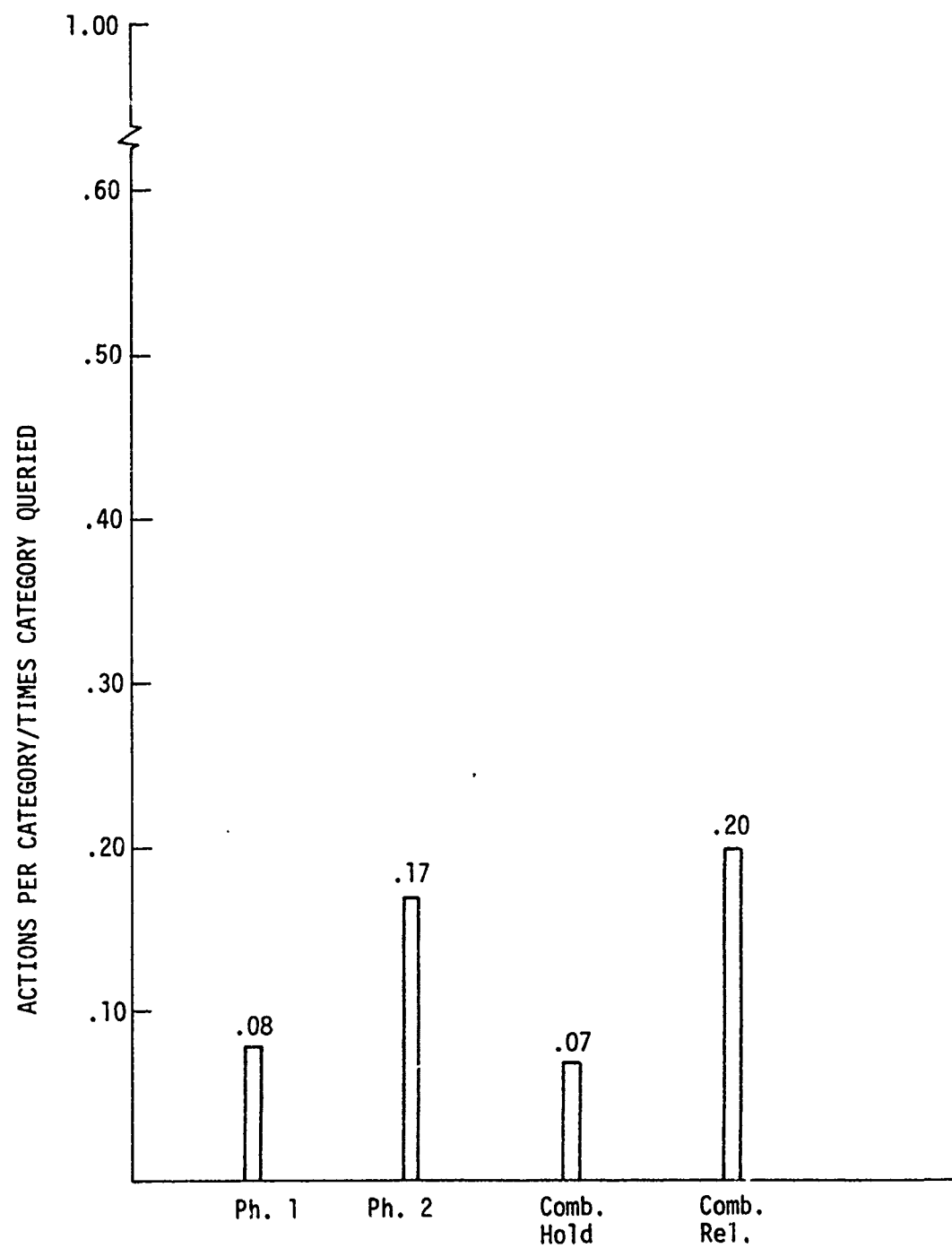
Figure B-18. Action Ratio: C#103
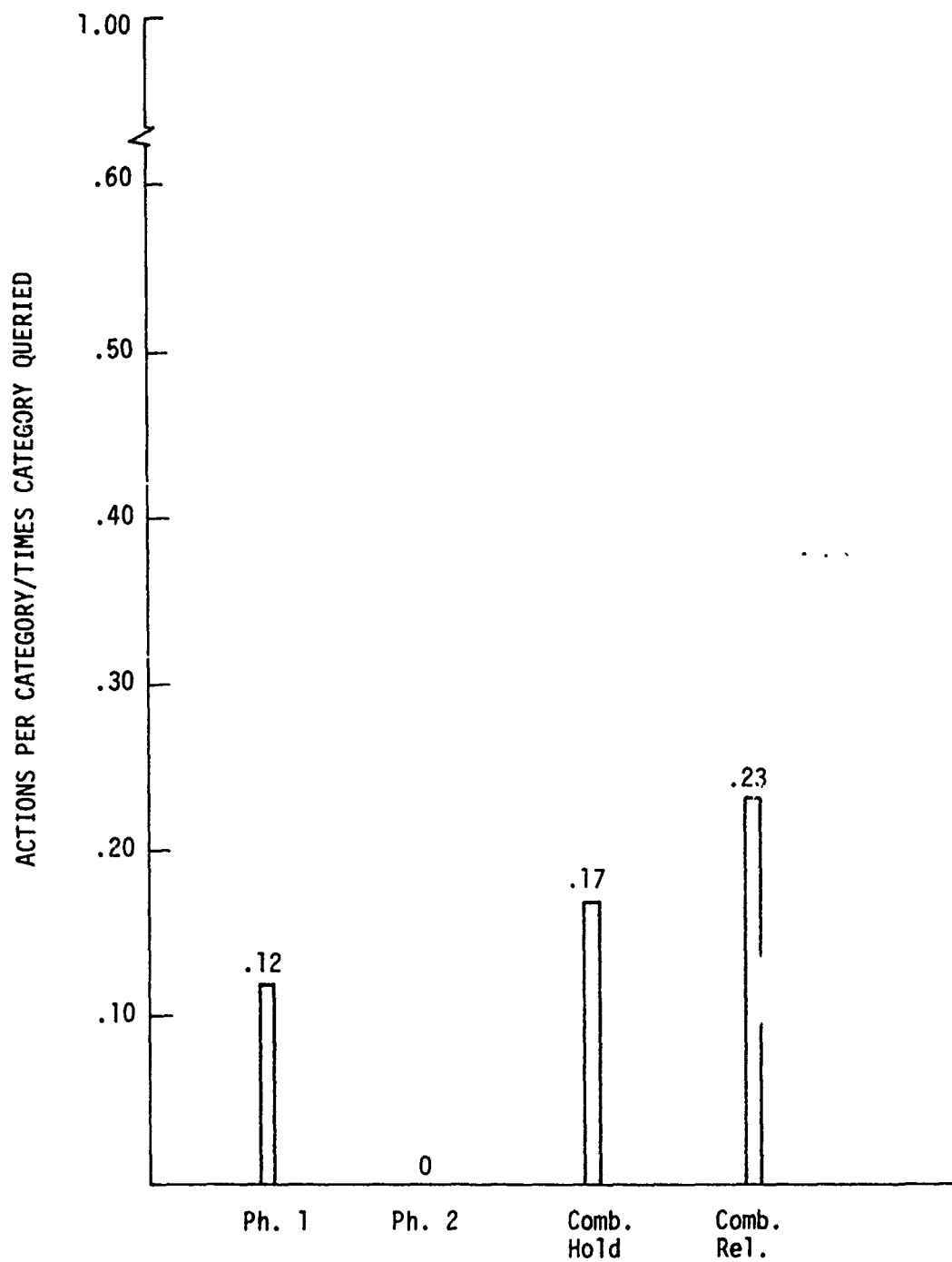
Figure B-19. Action Ratio: C#105
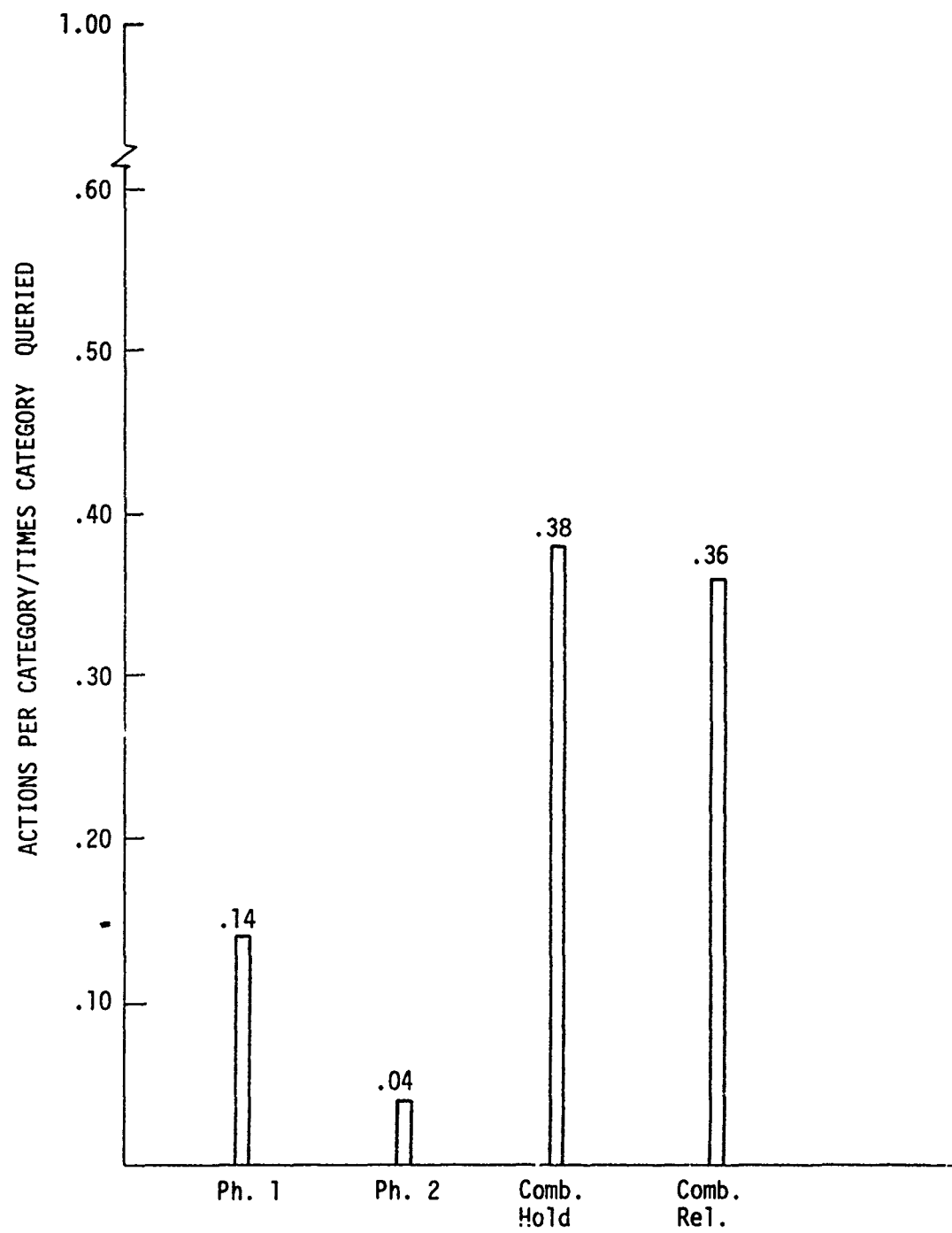
Figure B-20. Action Ratio: C#106
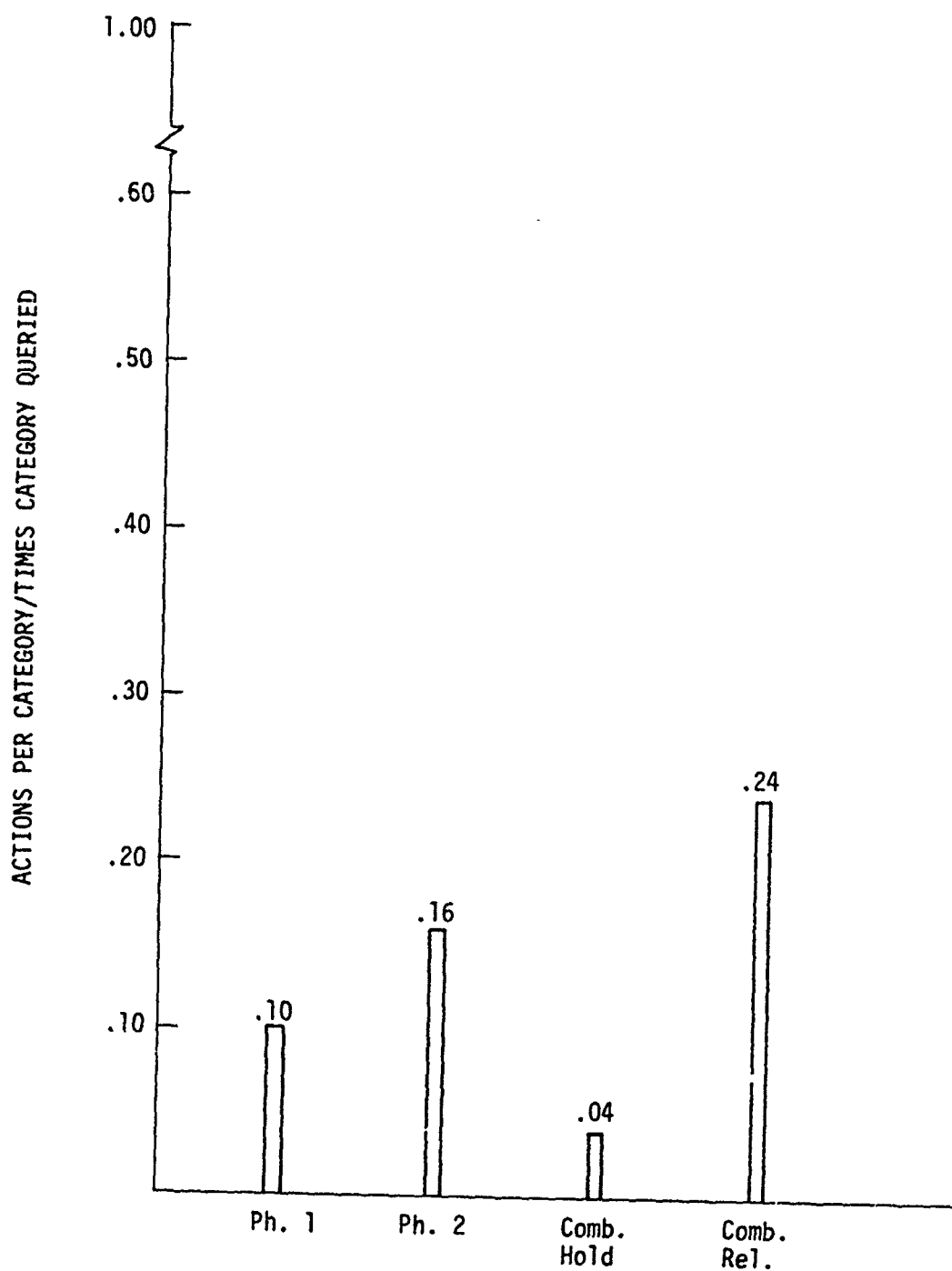
Figure B-21.   Action Ratio: C#202
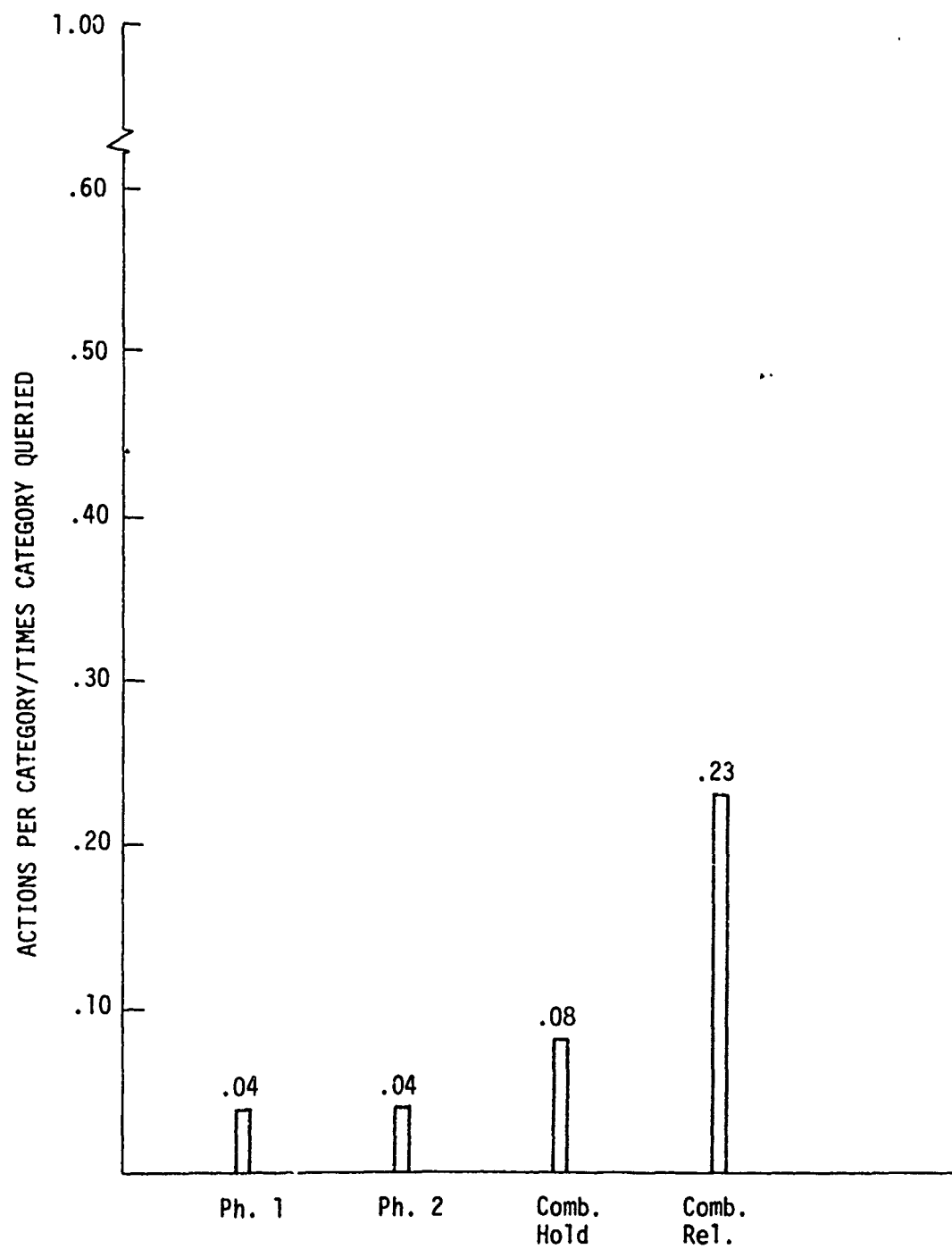
Figure B-22.   Action Ratio: C#203
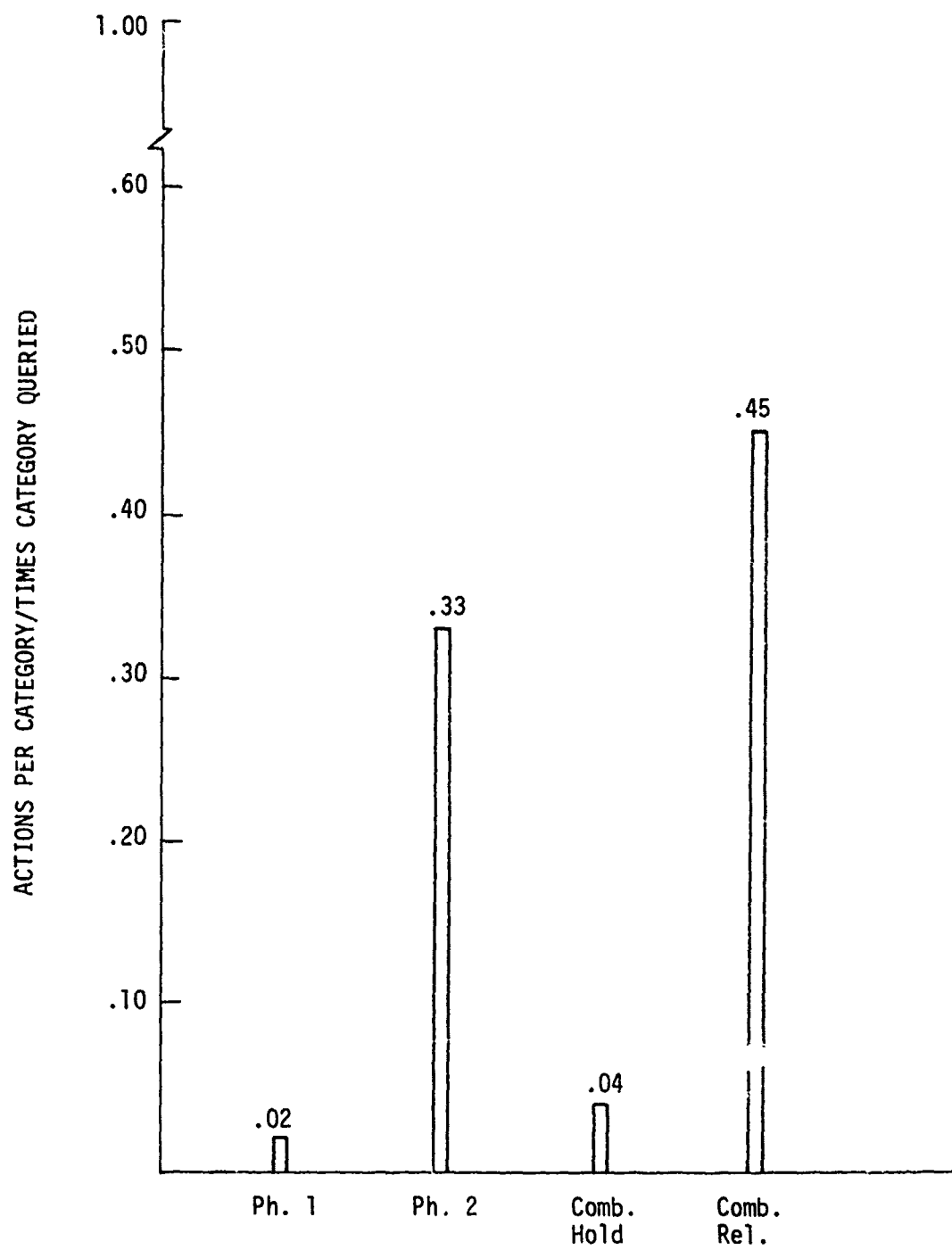
Figure B-23. Action Ratio: C#204
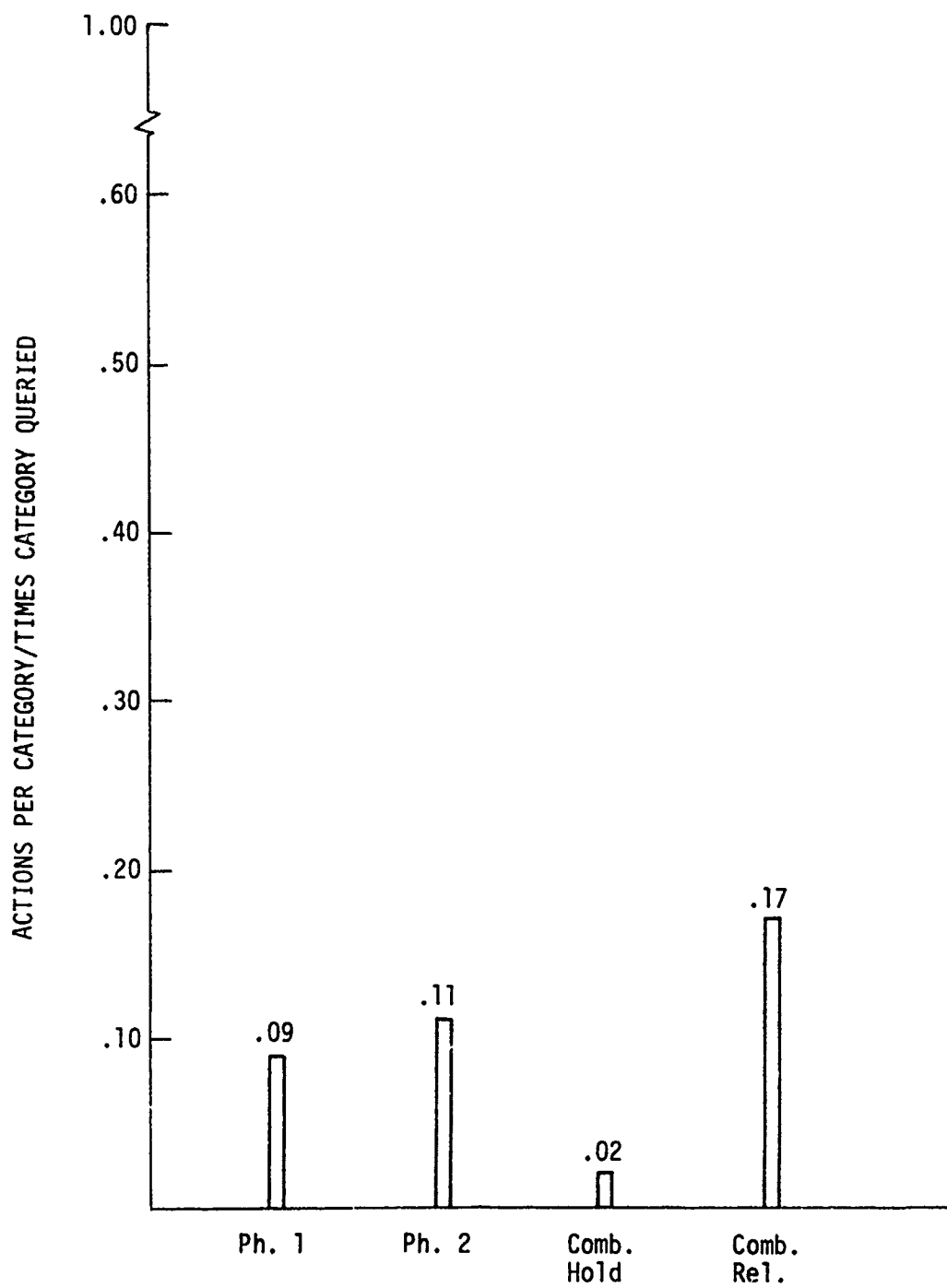
Figure E-24.   Action Ratio: C#205
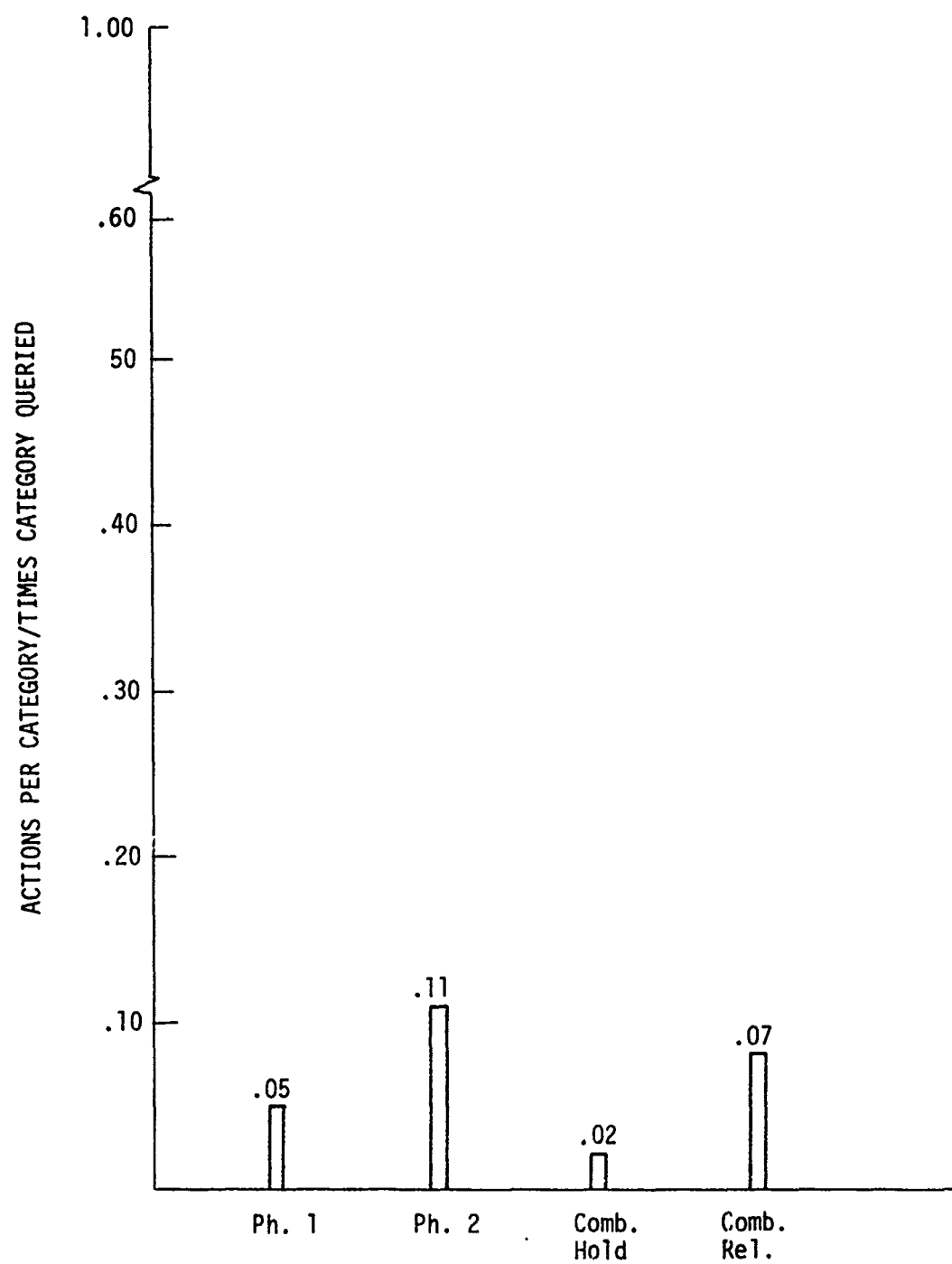
Figure B-25.   Action Ratio: C#206
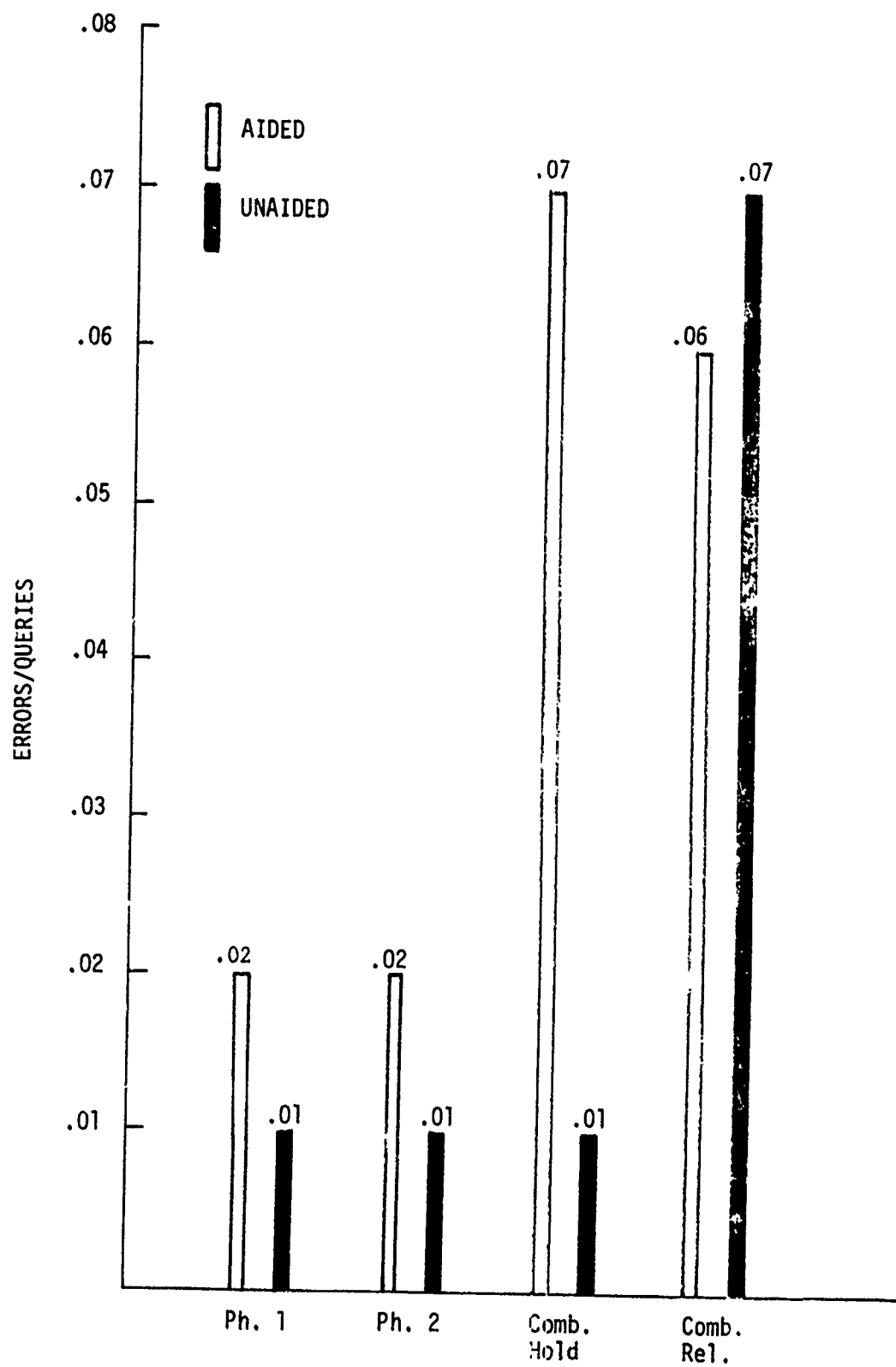
Figure B-26. Error Ratio: Aided/Unaided
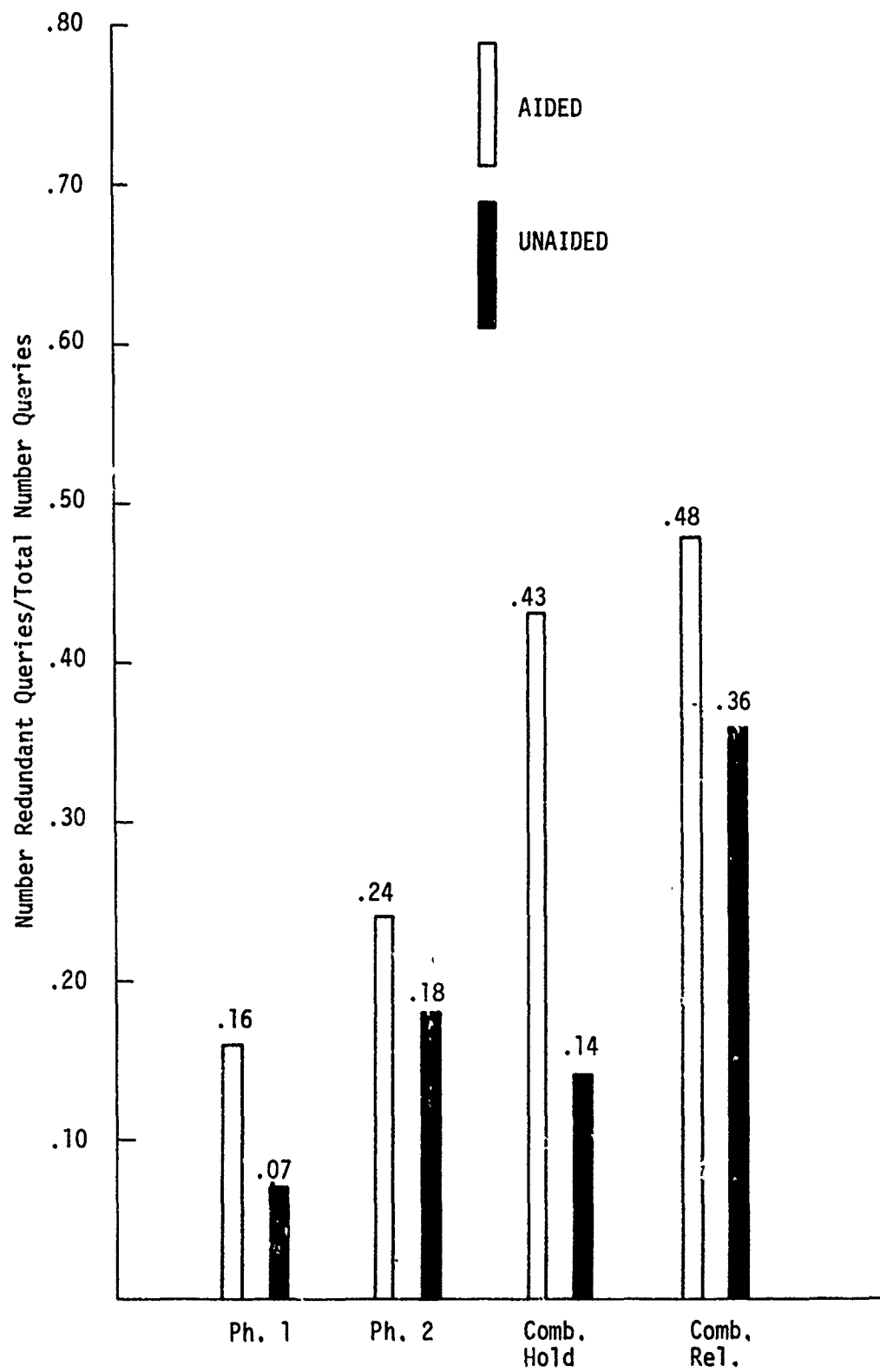
Figure B-27. Redundancy Ratio: Aided/Unaided
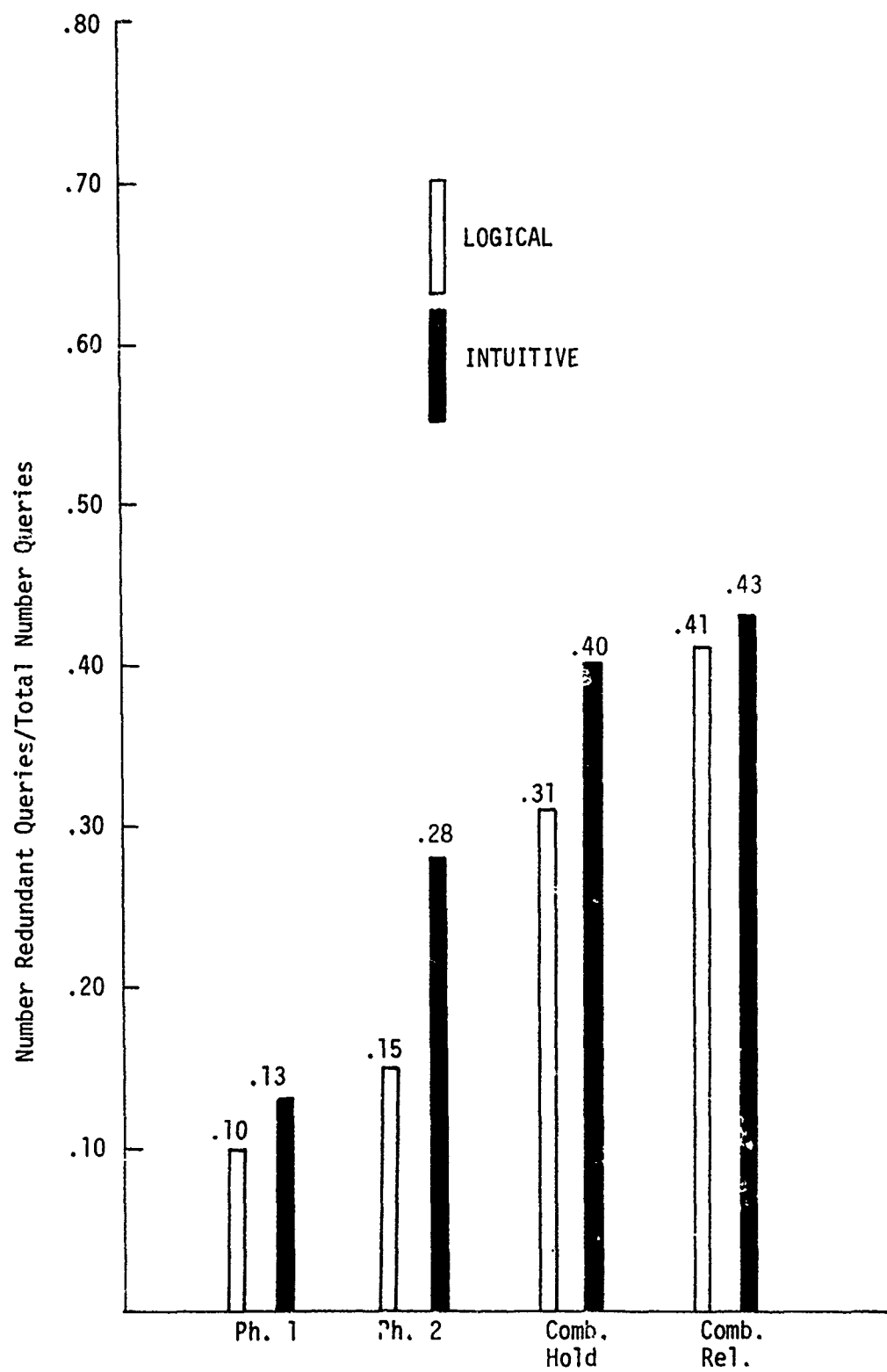
Figure B-28. Redundancy Ratio: Logical/Intuitive
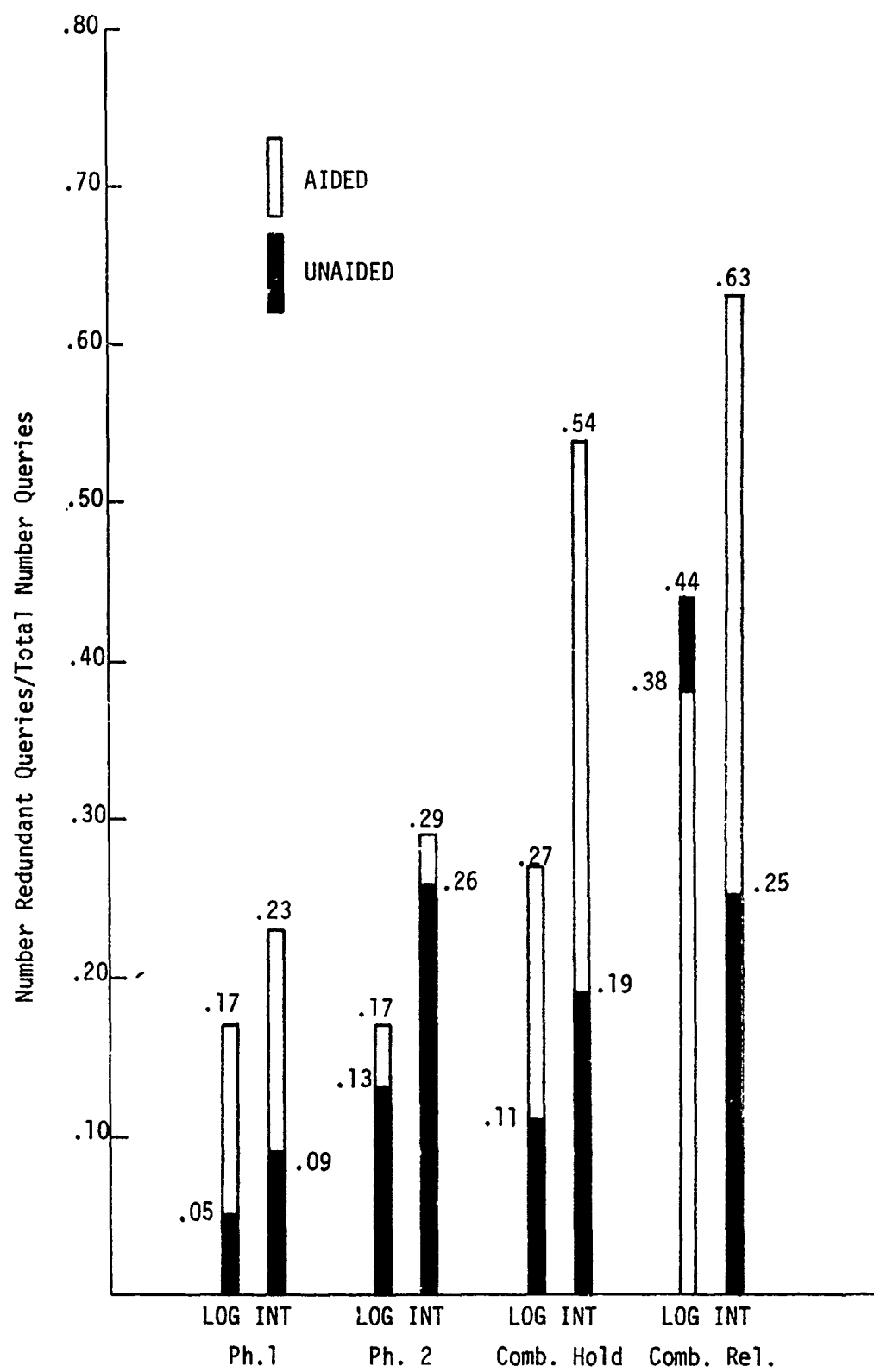
Figure B-29.   Redundancy Ratio: Logical/Intuitive (Aided/Unaided)
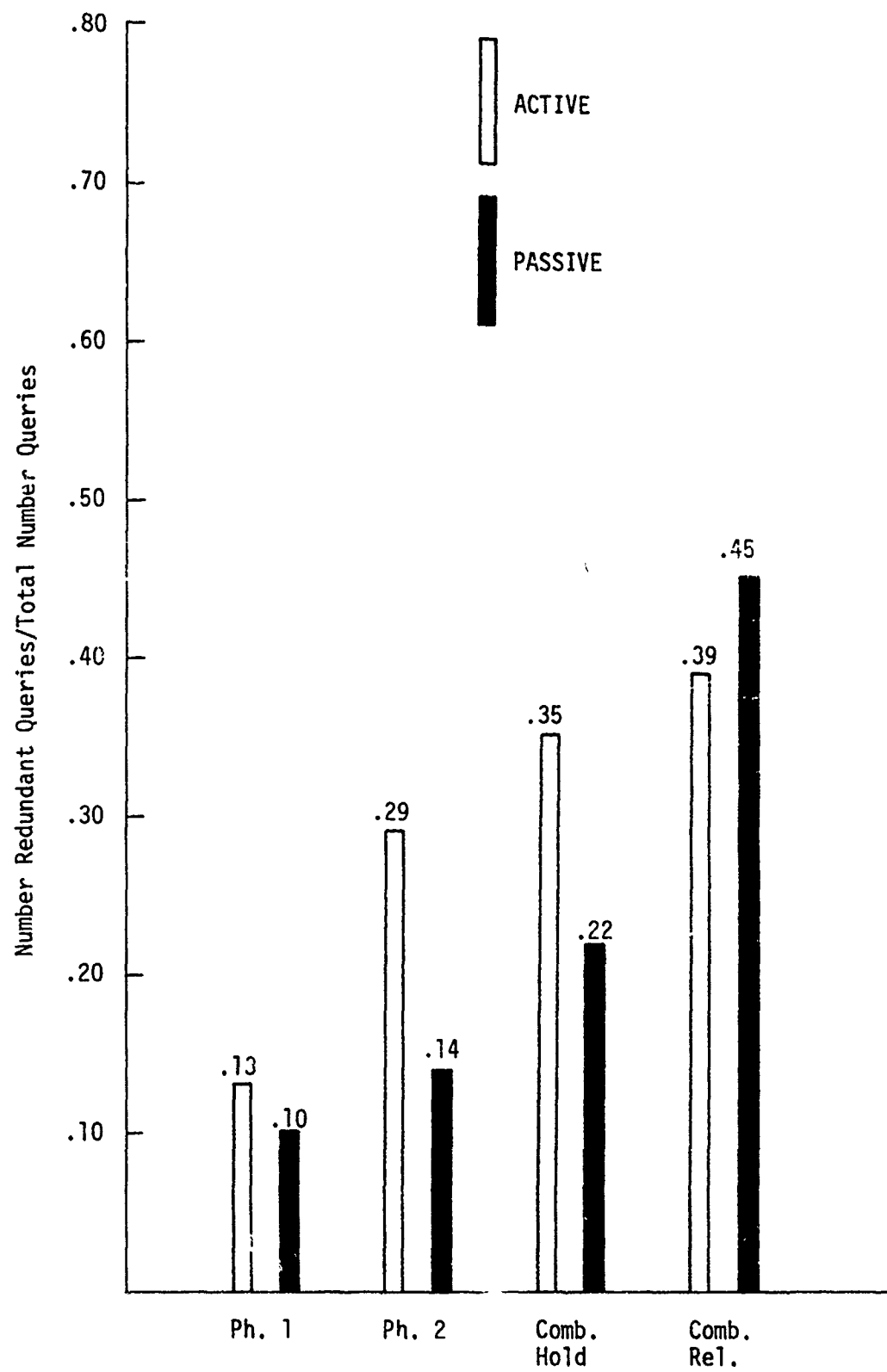
Figure B-30. Redundancy Ratio: Active/Passive
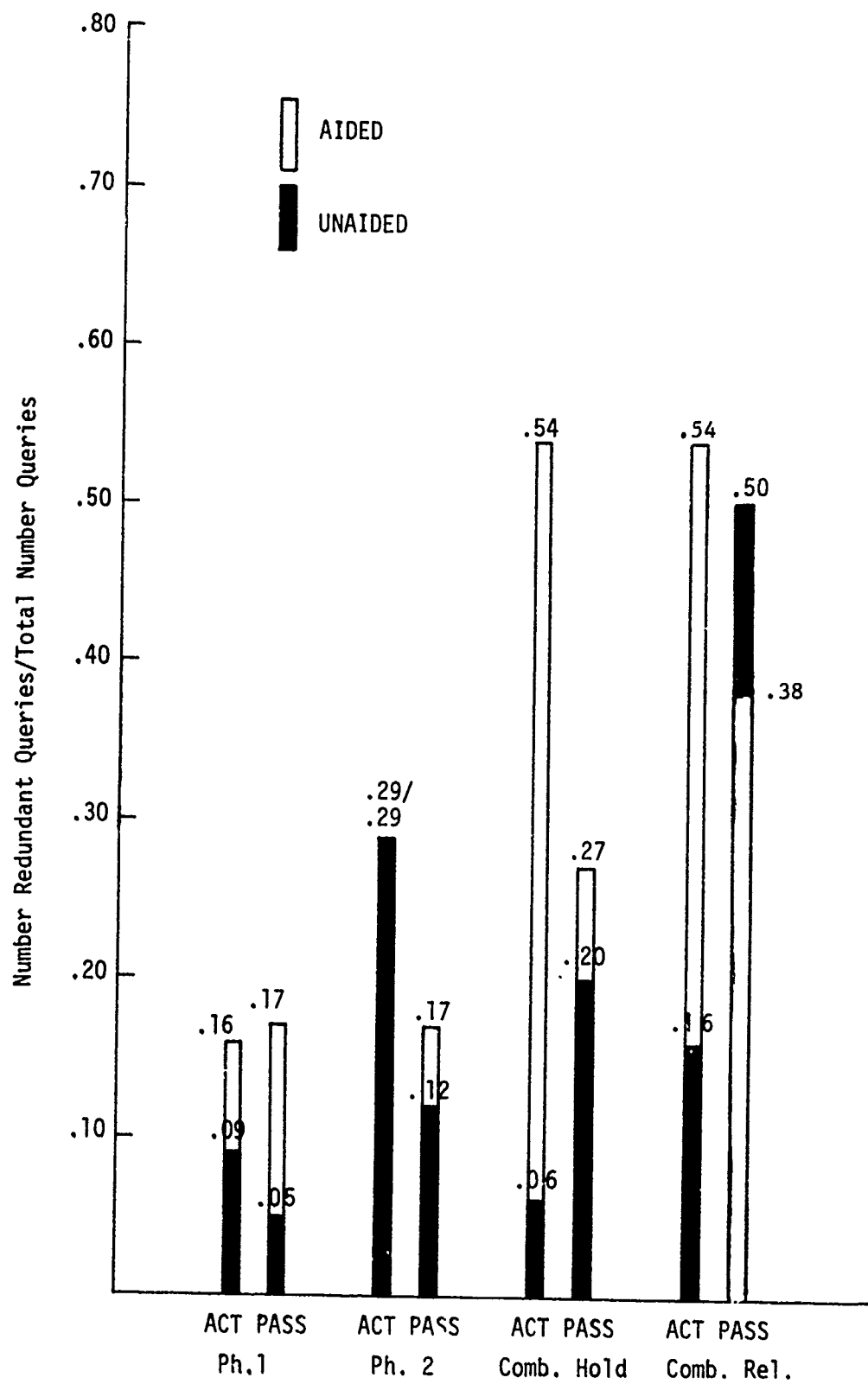
Figure B-31.   Redundancy Ratio: Active/Passive
                                    (Aided and Unaided)
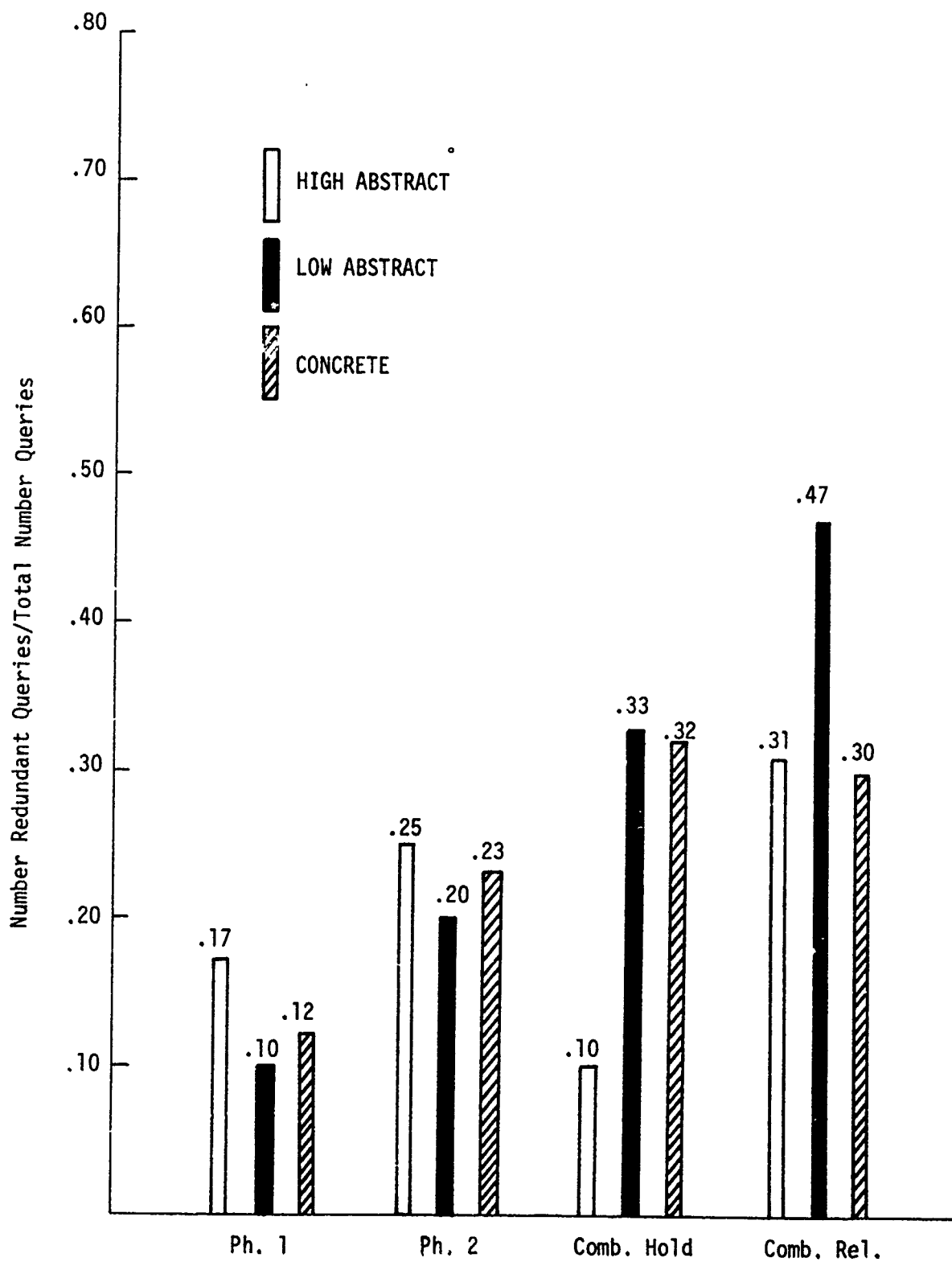
Figure B-32. Redundancy Ratio: High Abstract/Low Abstract/Concrete
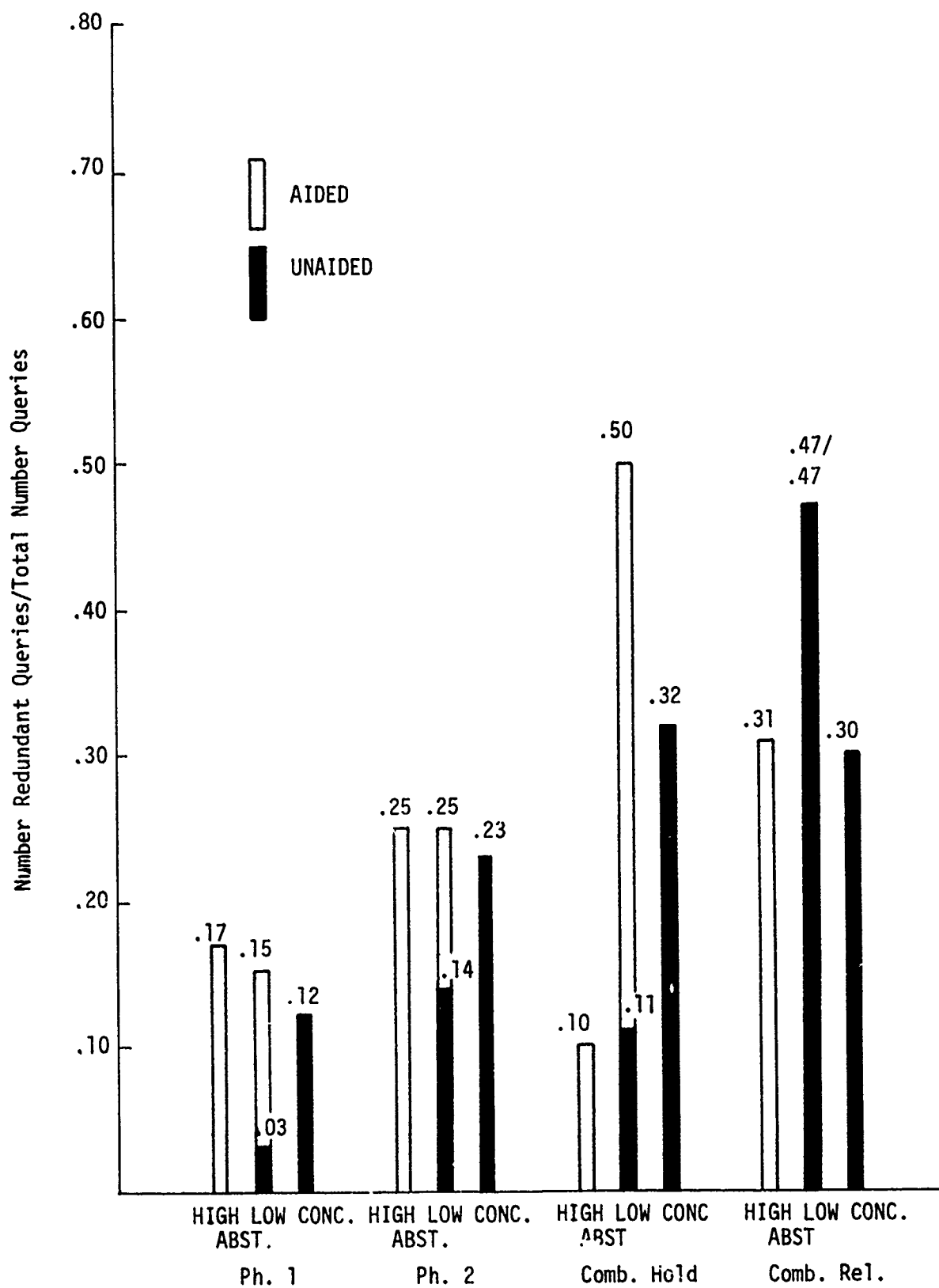
Figure B-33. Redundancy Ratio: High Abstract/Low Abstract/Concrete
(Aided and Unaided)
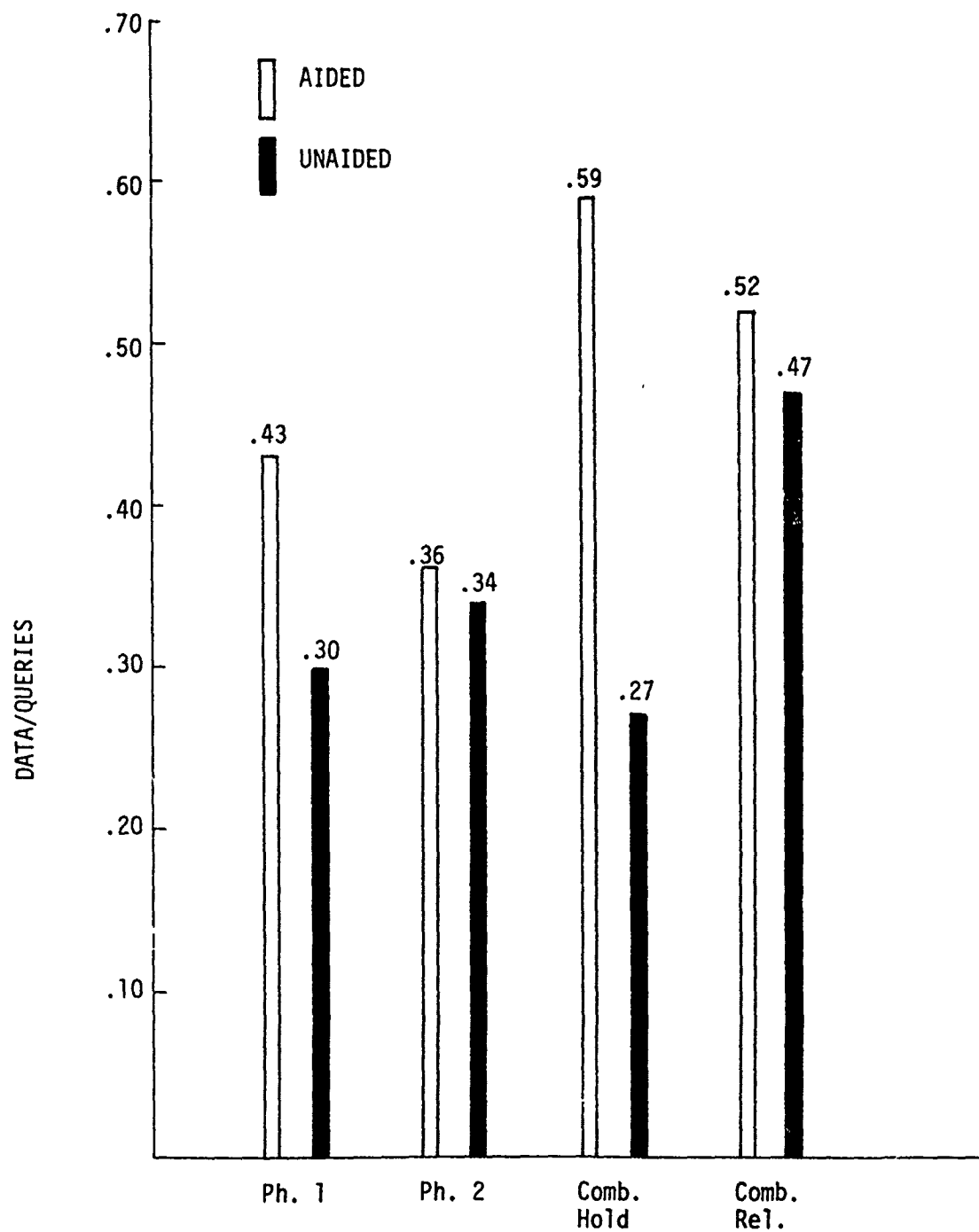
Figure B-34. Information Acquisition: Aided/Unaided
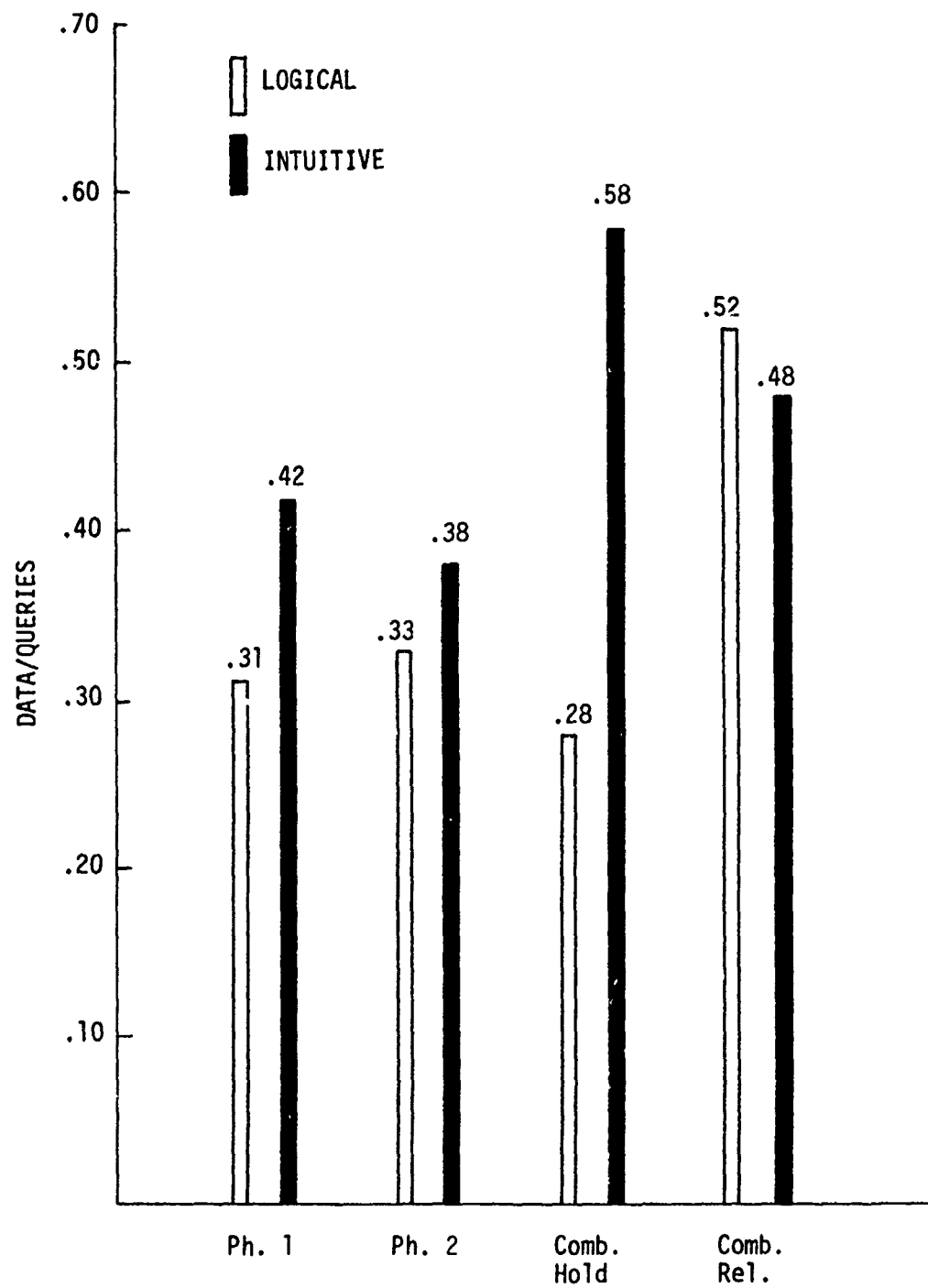
Figure B-35.   Information Acquisition: Logical/Intuitive
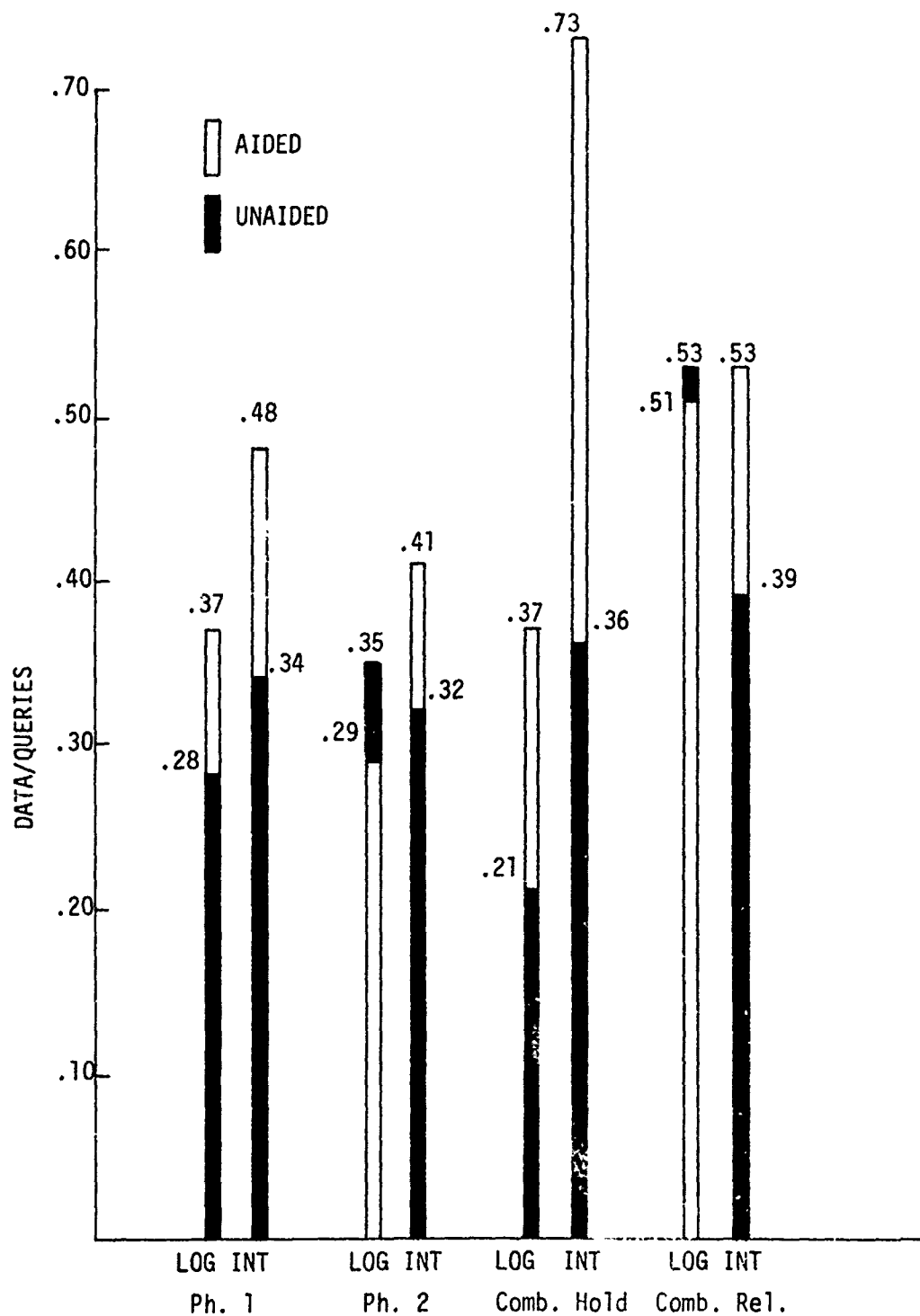
Figure B-36.   Information Acquisition: Logical/Intuitive
(Aided and Unaided)
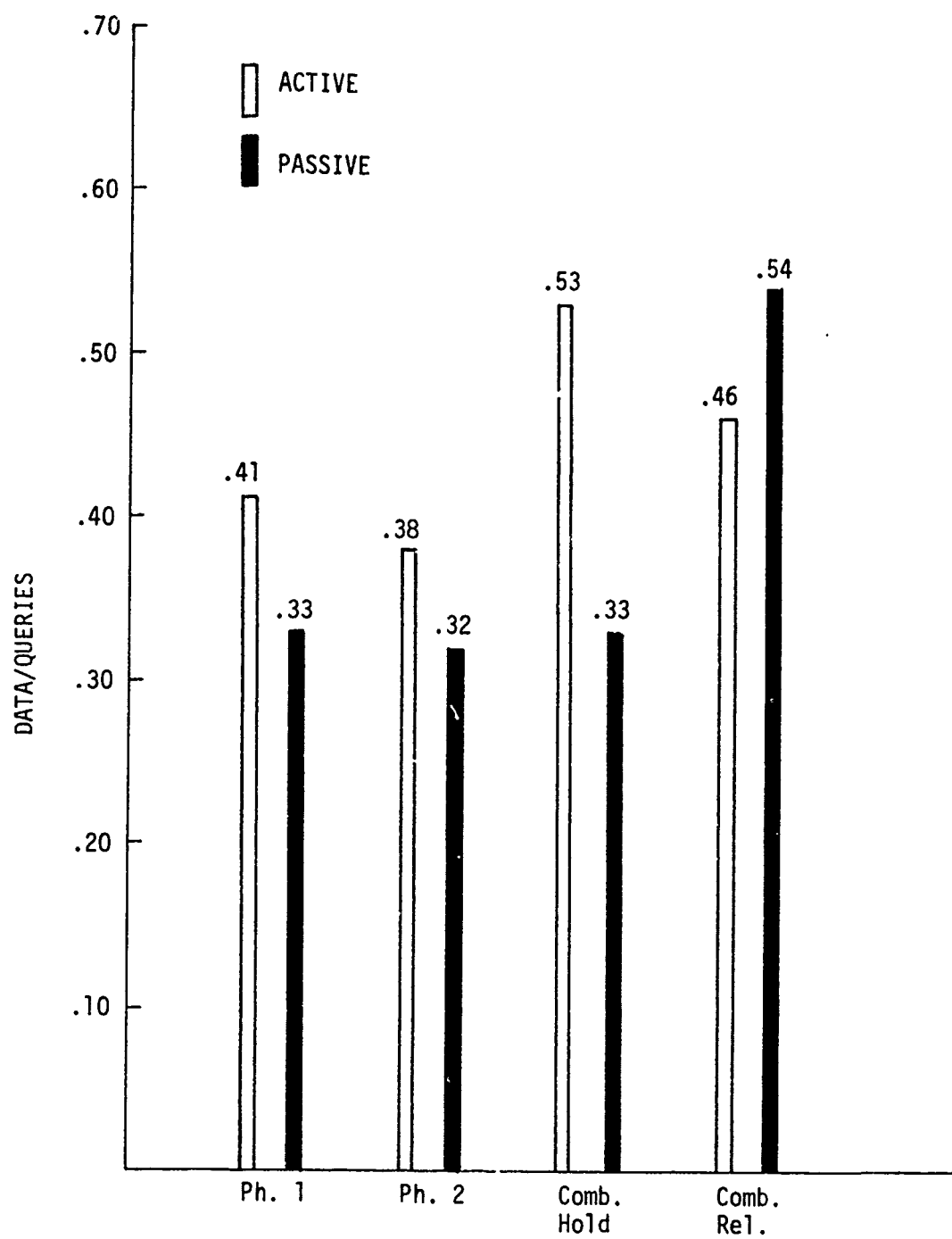
Figure B-37. Information Acquisition: Active/Passive
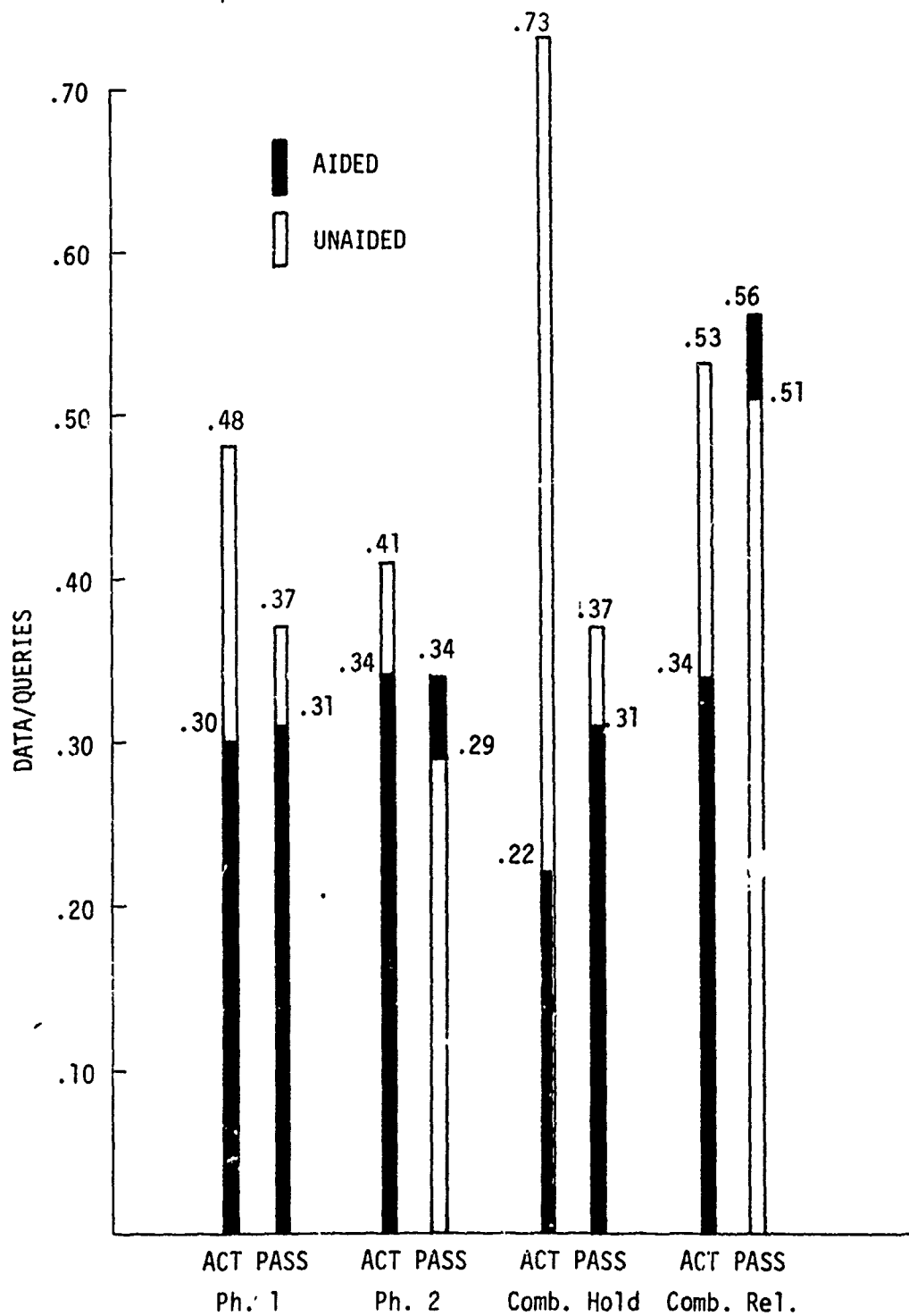
Figure B-38.   Information Acquisition: Active/Passive
(Aided and Unaided)
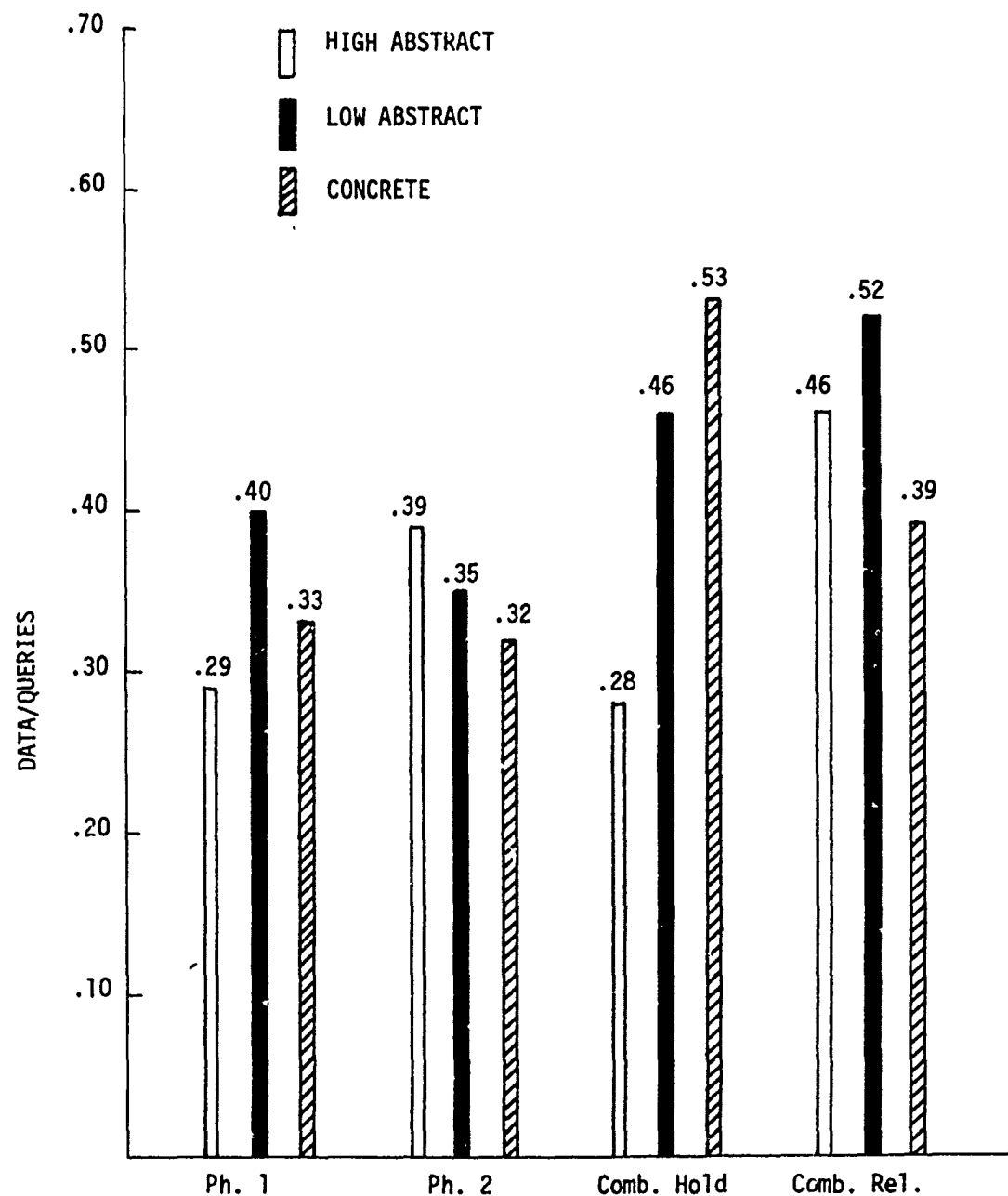
Figure B-39. Information Acquisition: High Abstract/Low Abstract/Concrete
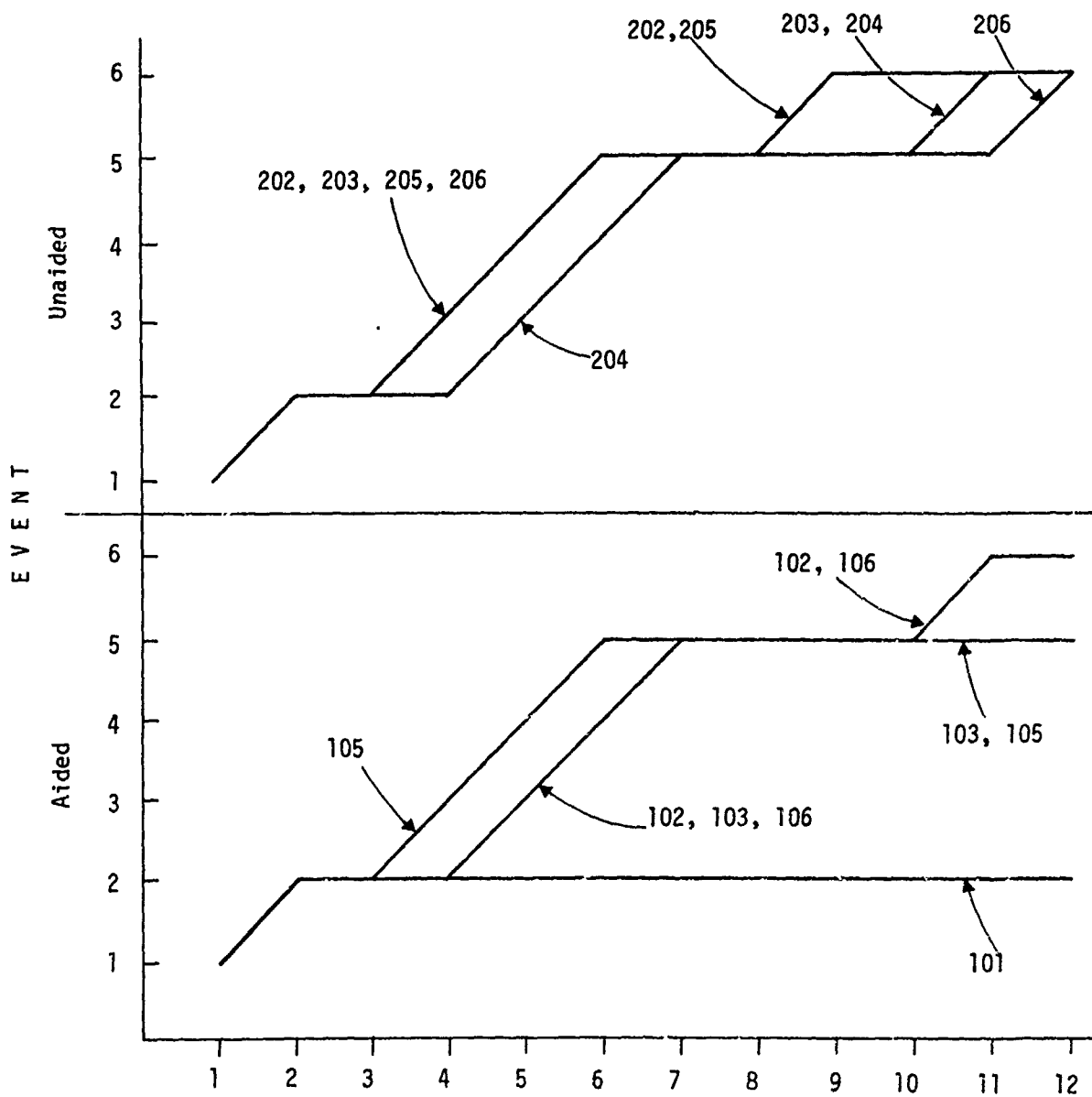
Figure B-40. Event X Update for Aided and Unaided Individual Consultants
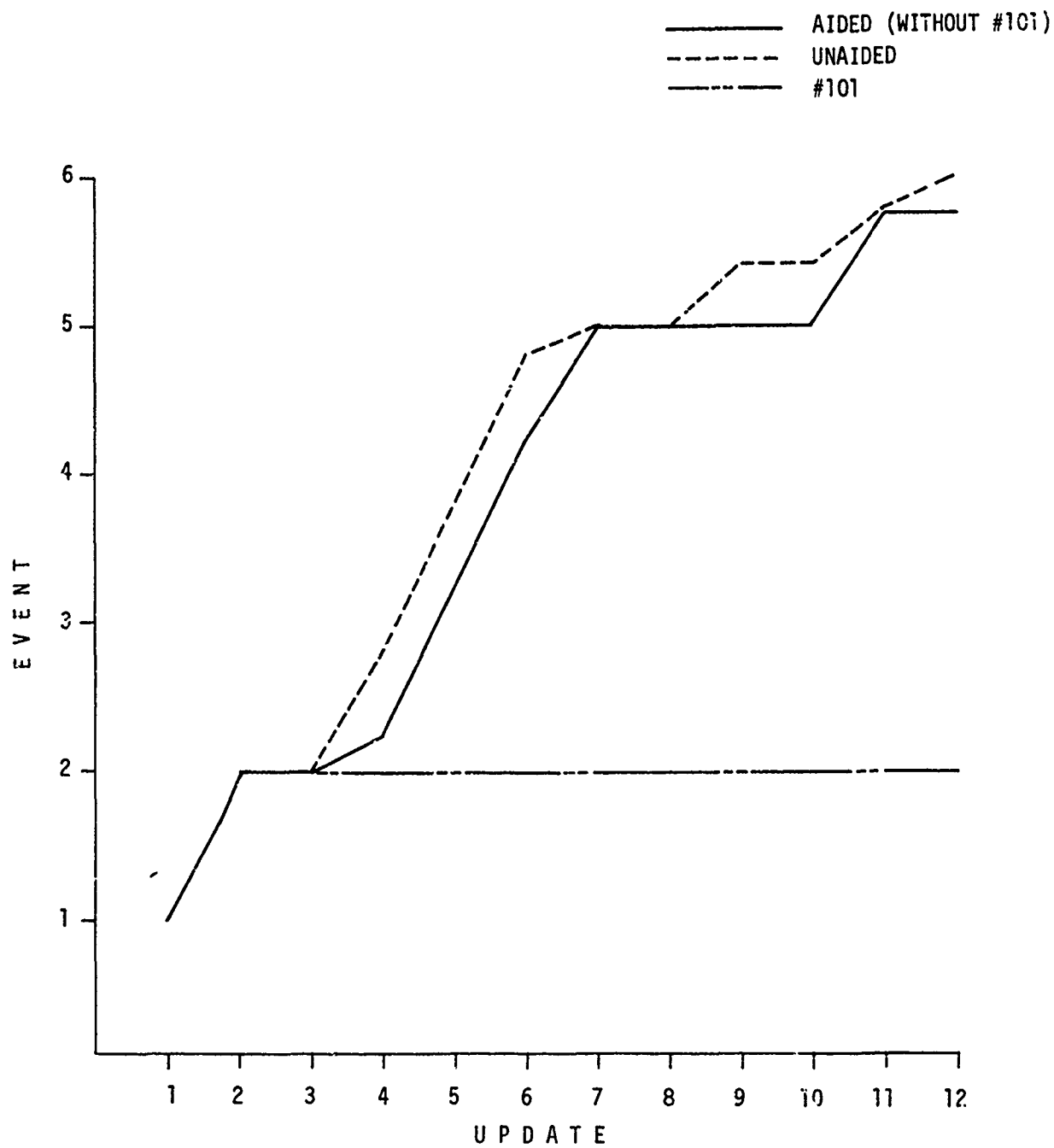
Figure B-41. Event x Update: Aided/Unaided (with and without #101)
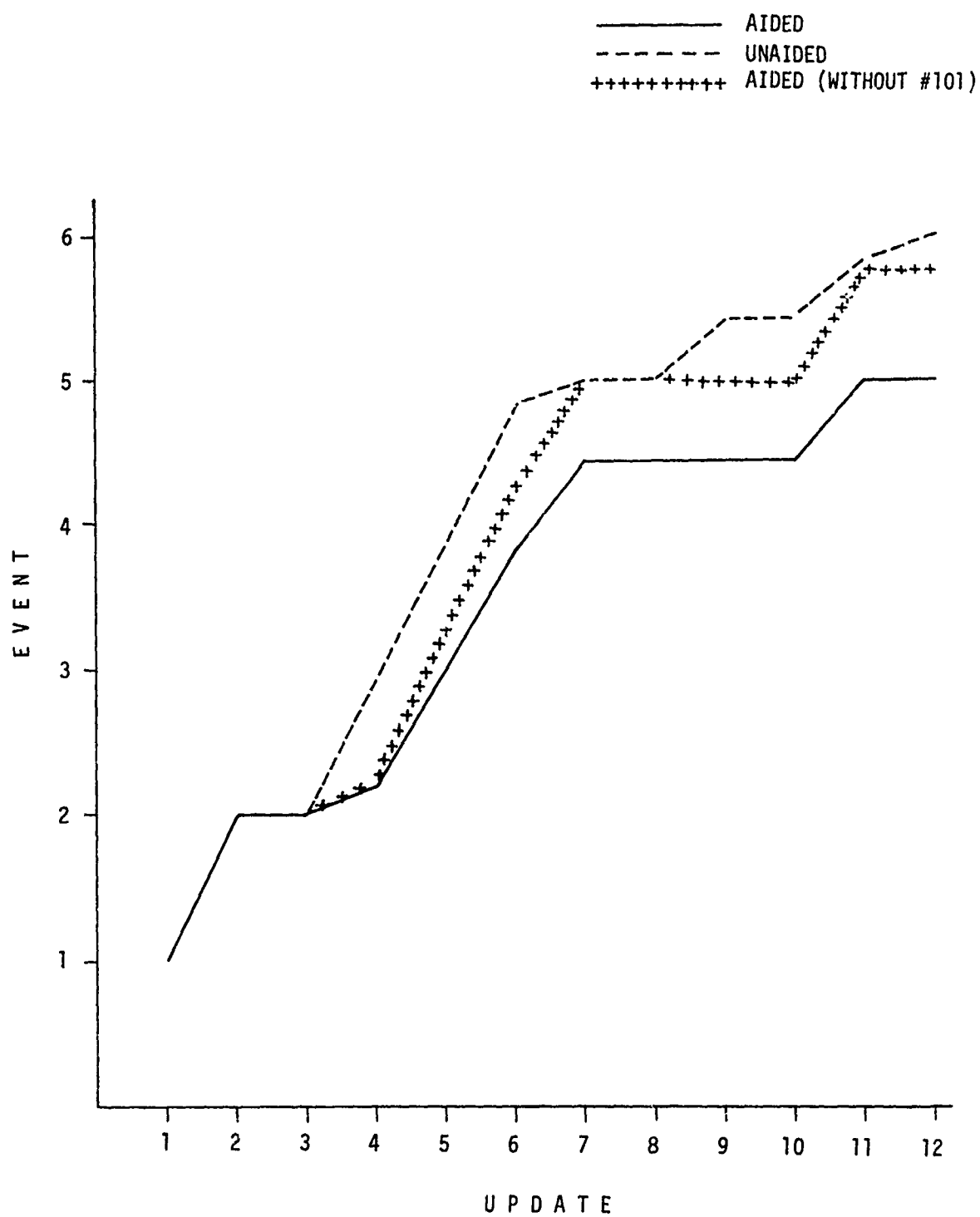
Figure B-42.   Event by Update: Aided/Unaided
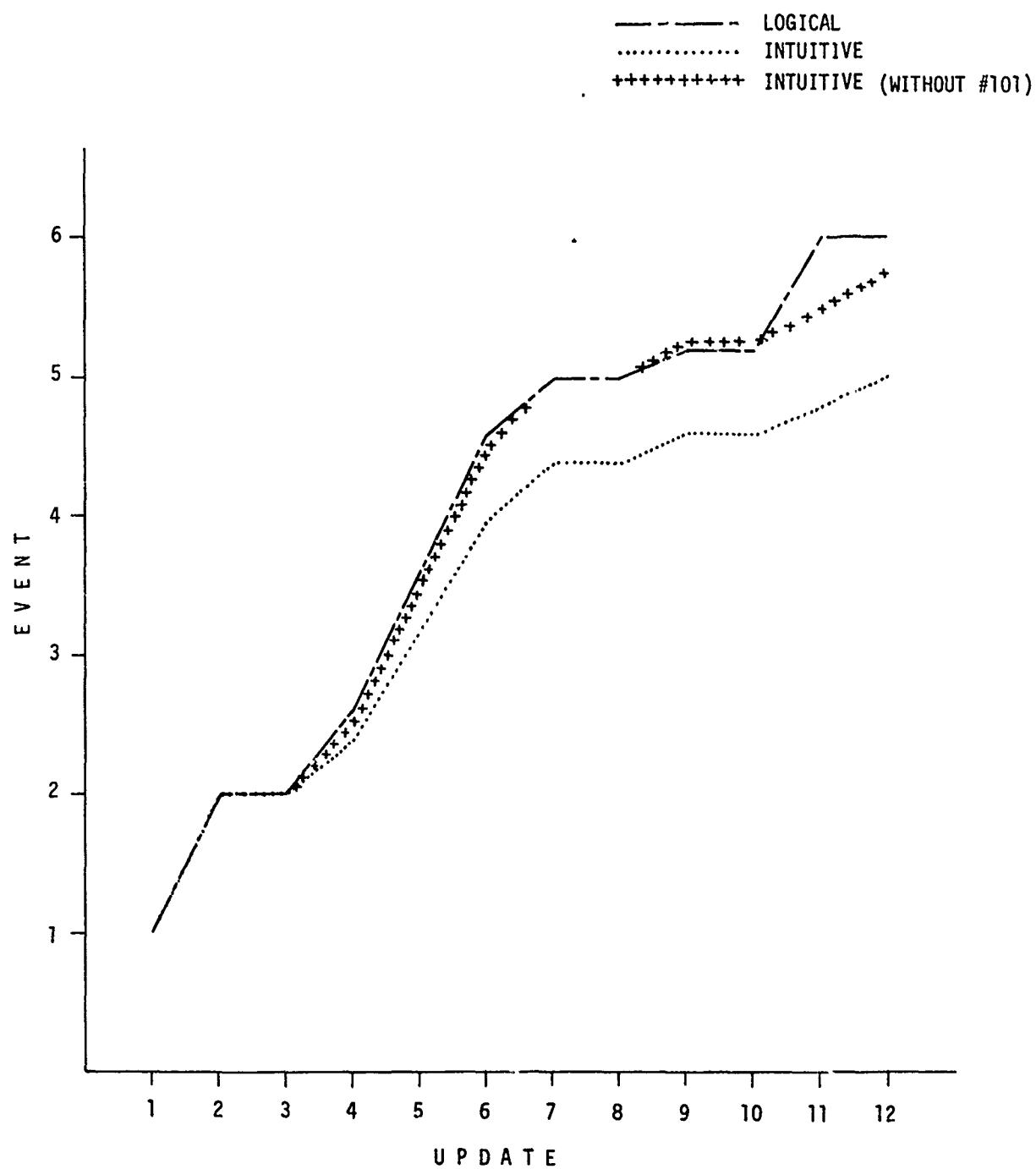
Figure B-43.   Event x Update: Logical/Intuitive
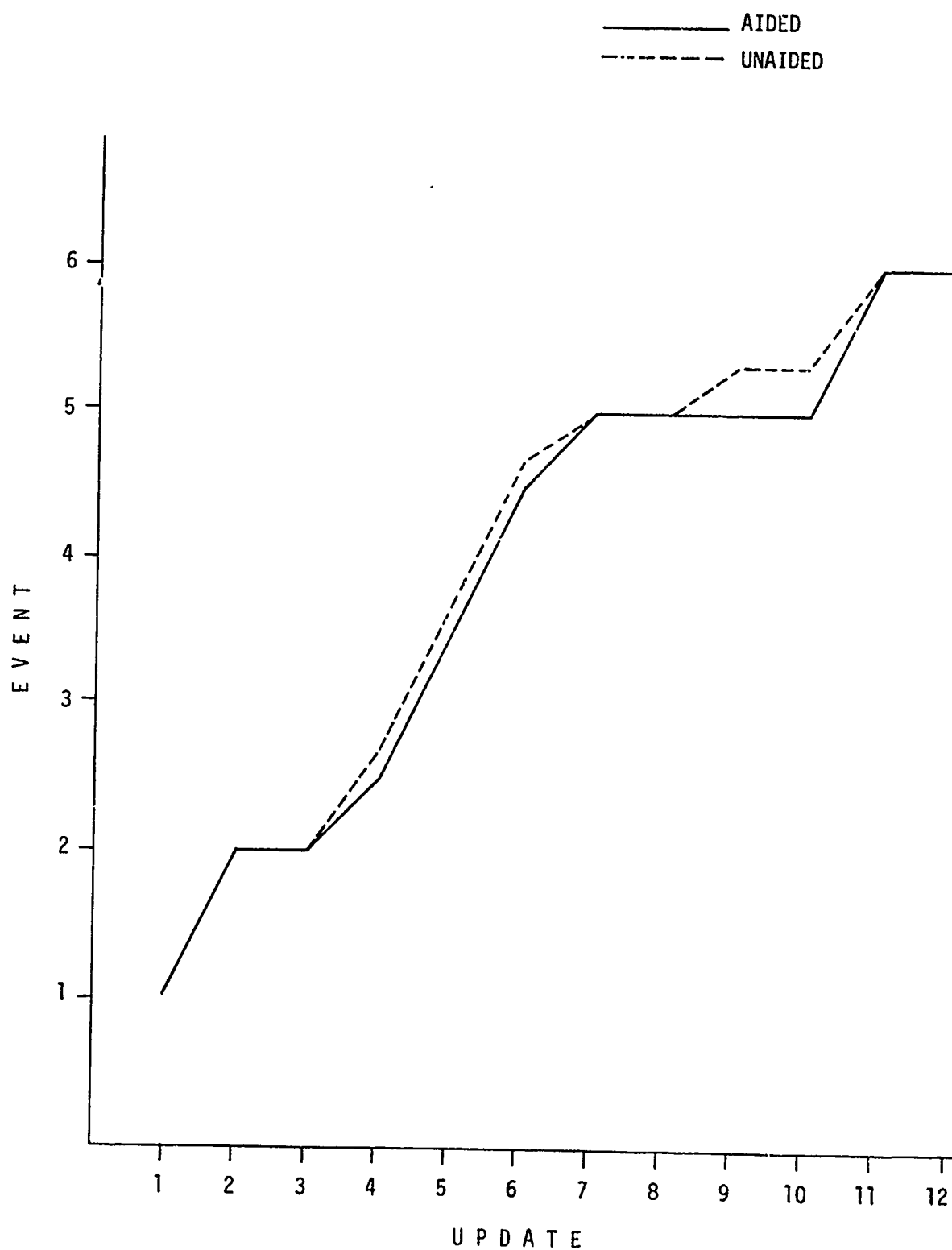
Figure B-44. Event x Update: Logical (Aided and Unaided)
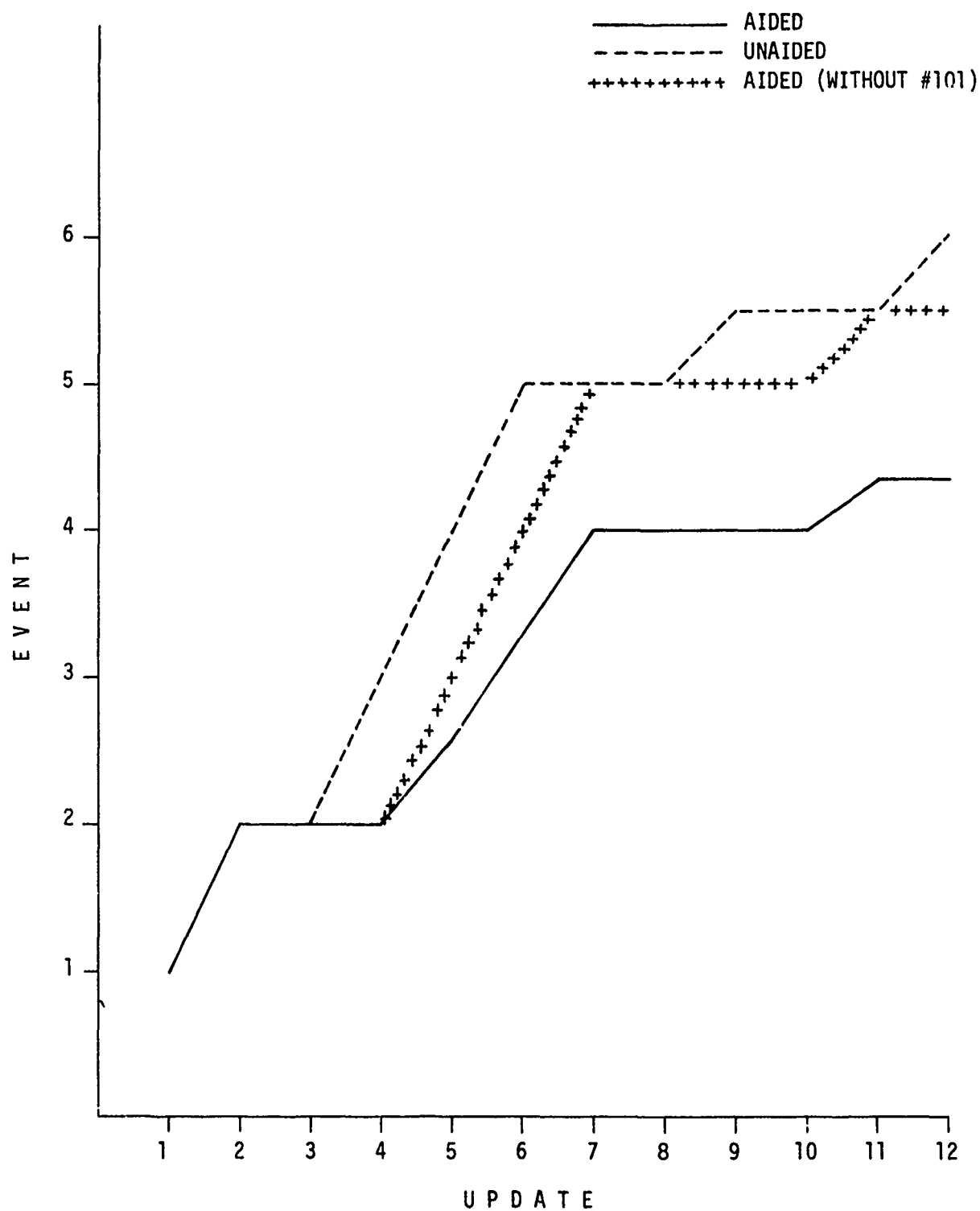
Figure B-45. Event x Update: Intuitive (Aided and Unaided)
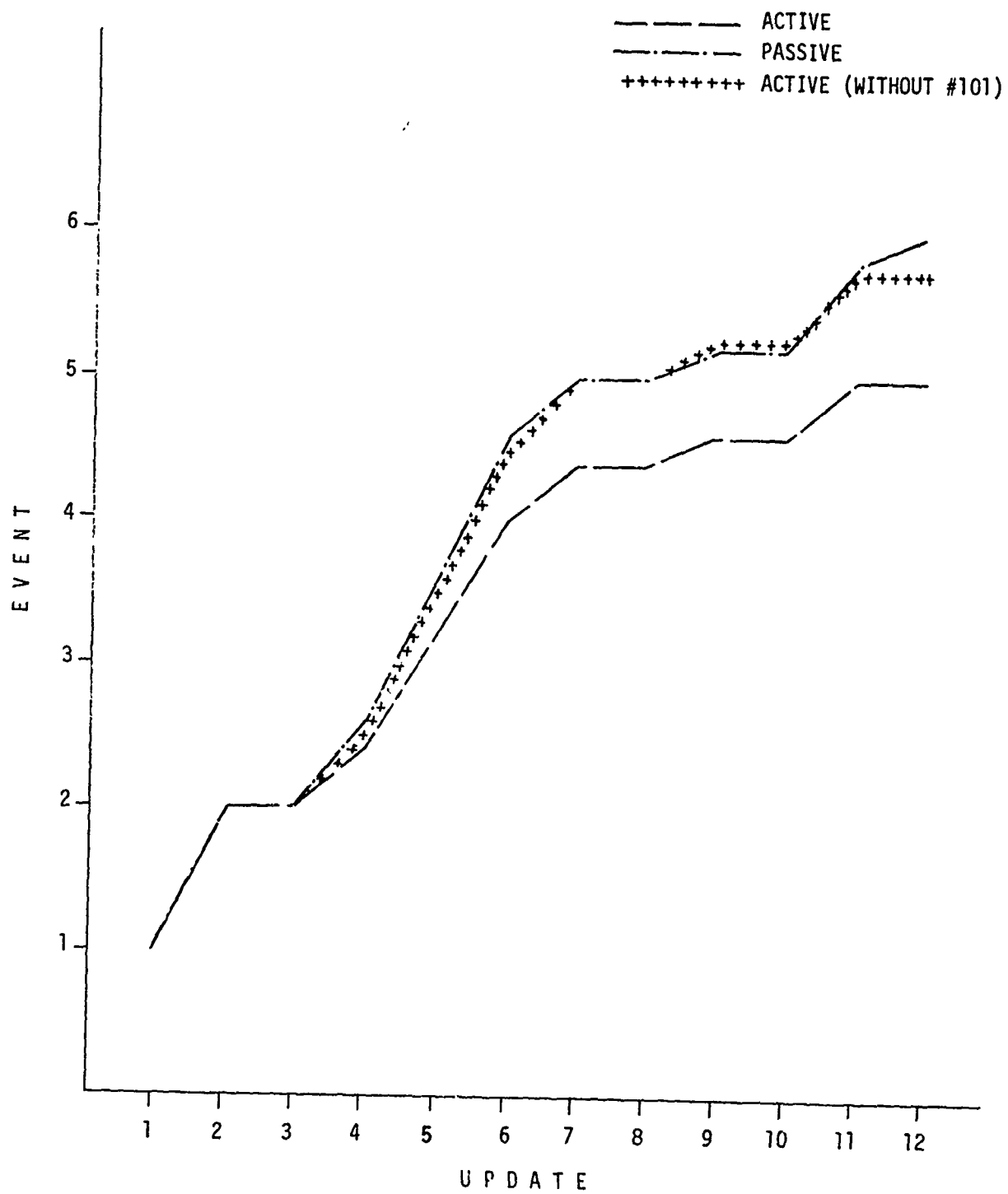
Figure B-46.   Event x Update: Active/Passive
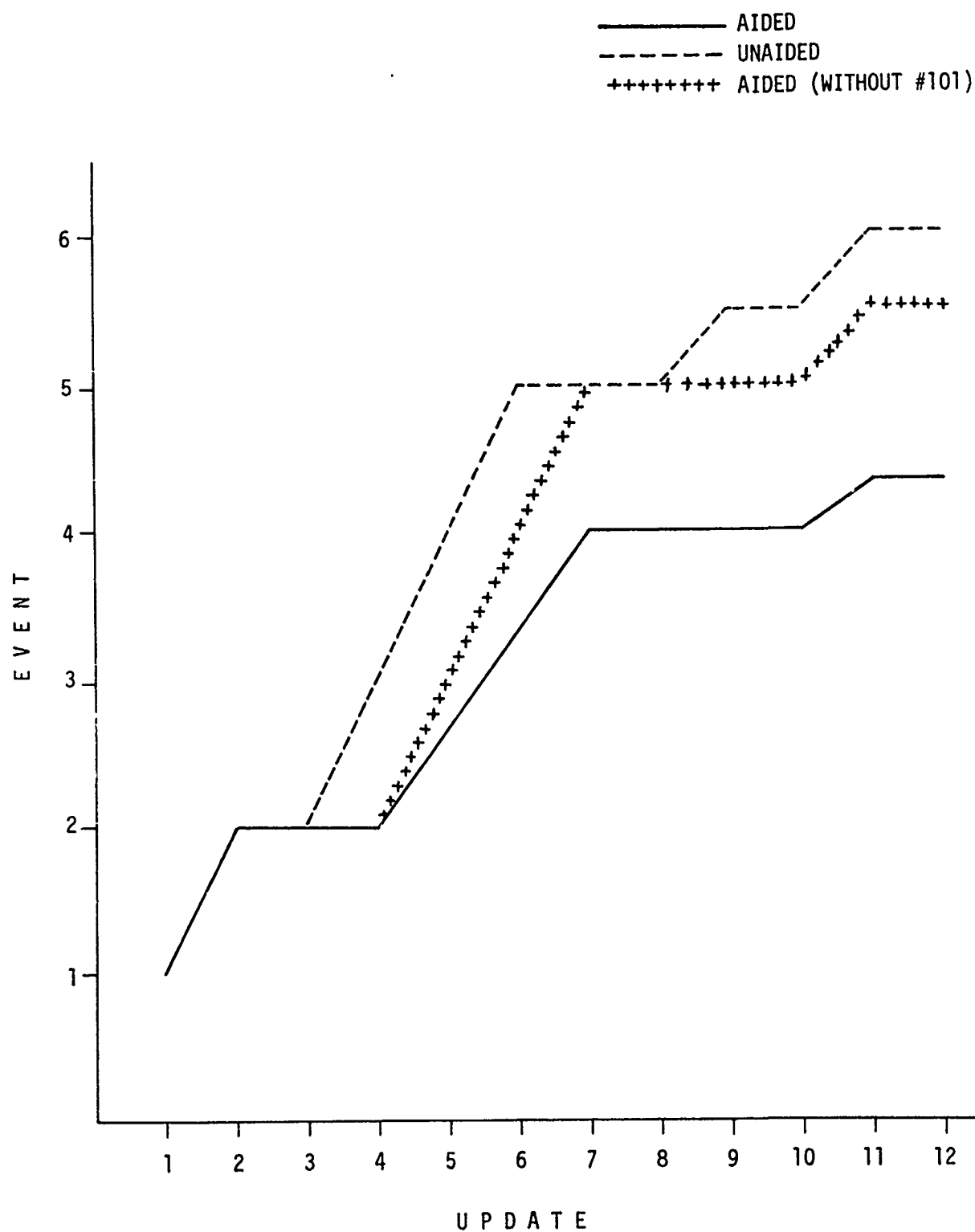
Figure B-47. Event x Update: Active (Aided and Unaided)
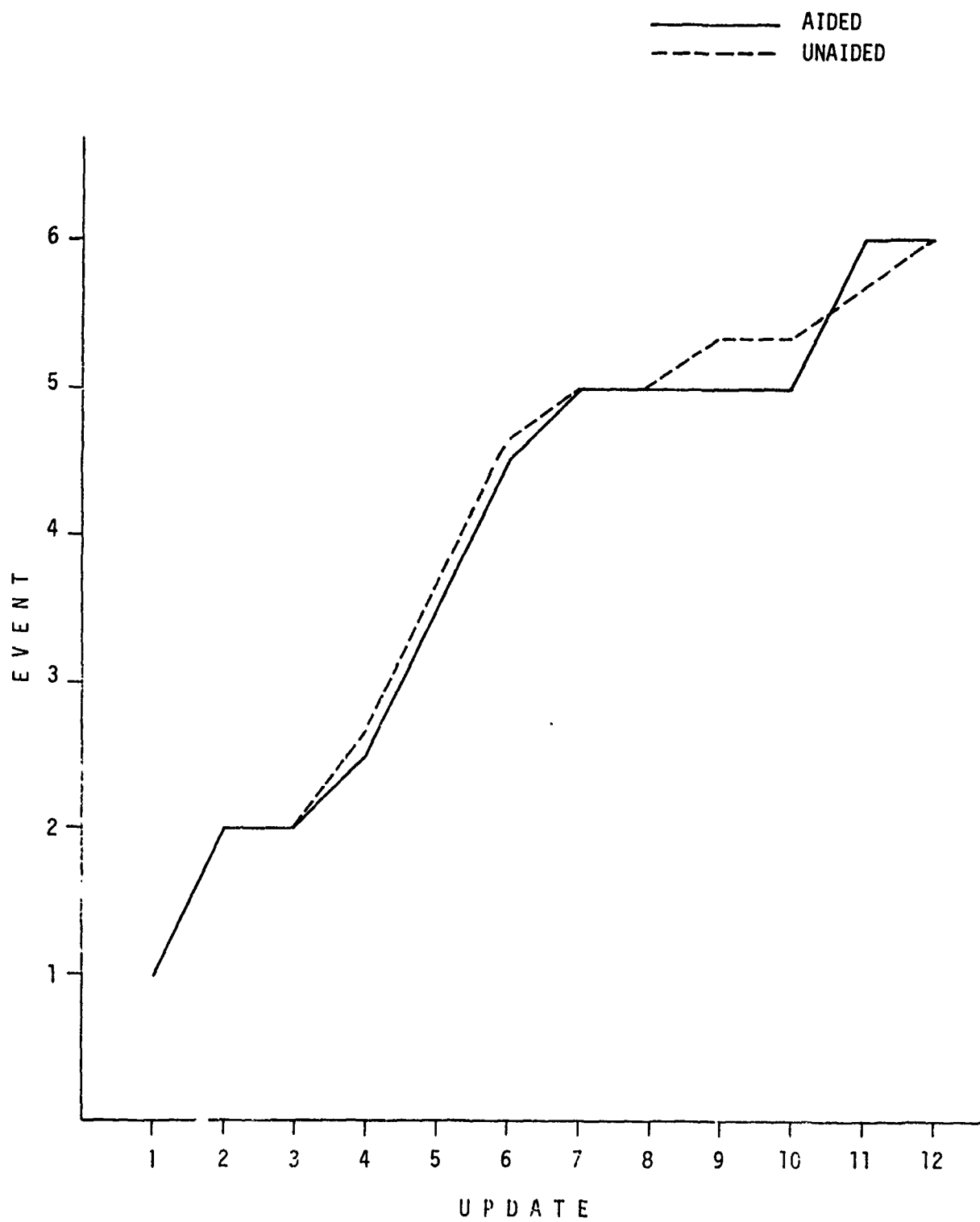
Figure B-48. Event x Update: Passive (Aided and Unaided)
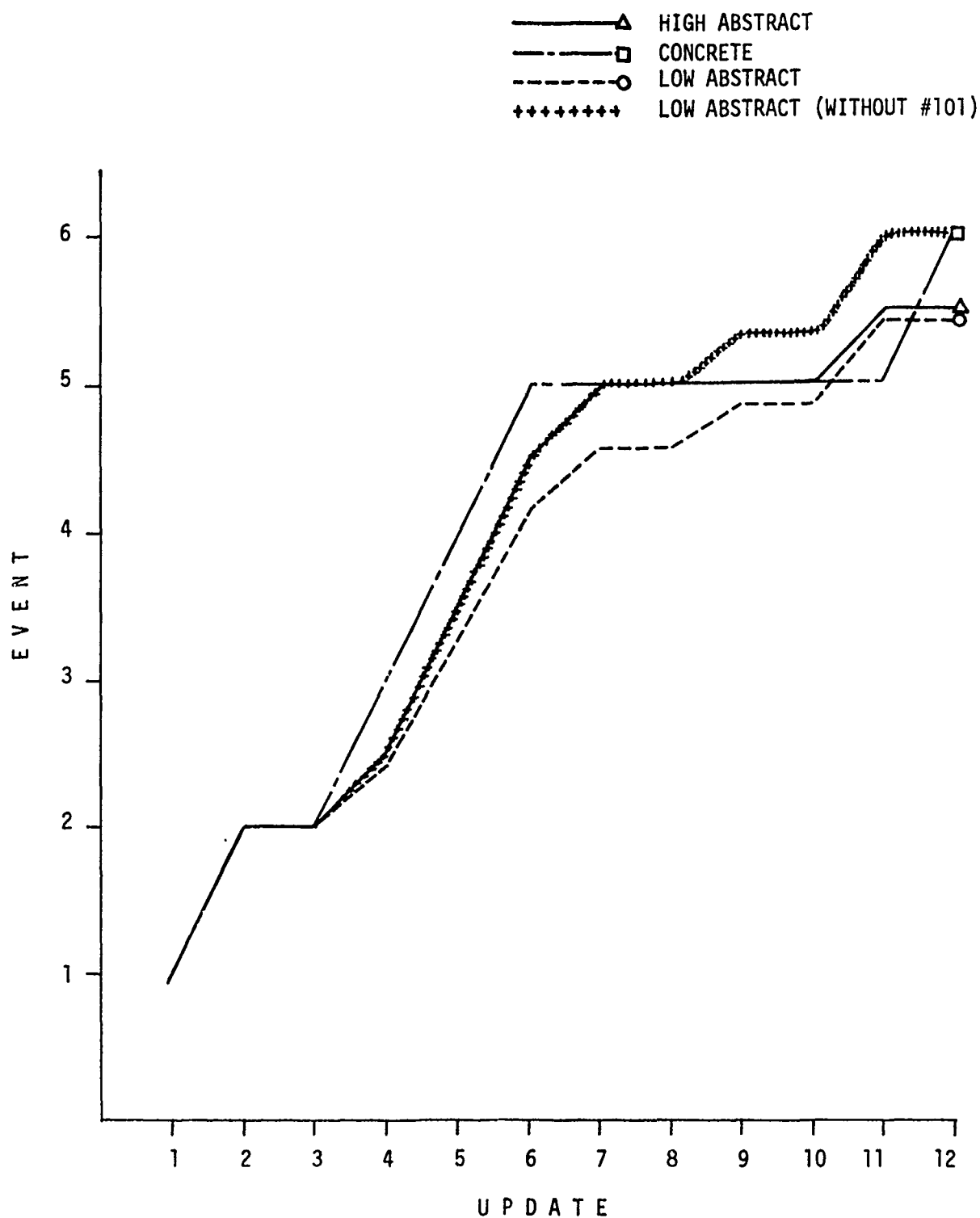
Figure B-49.   Event x Update: High Abstract/Low Abstract/Concrete
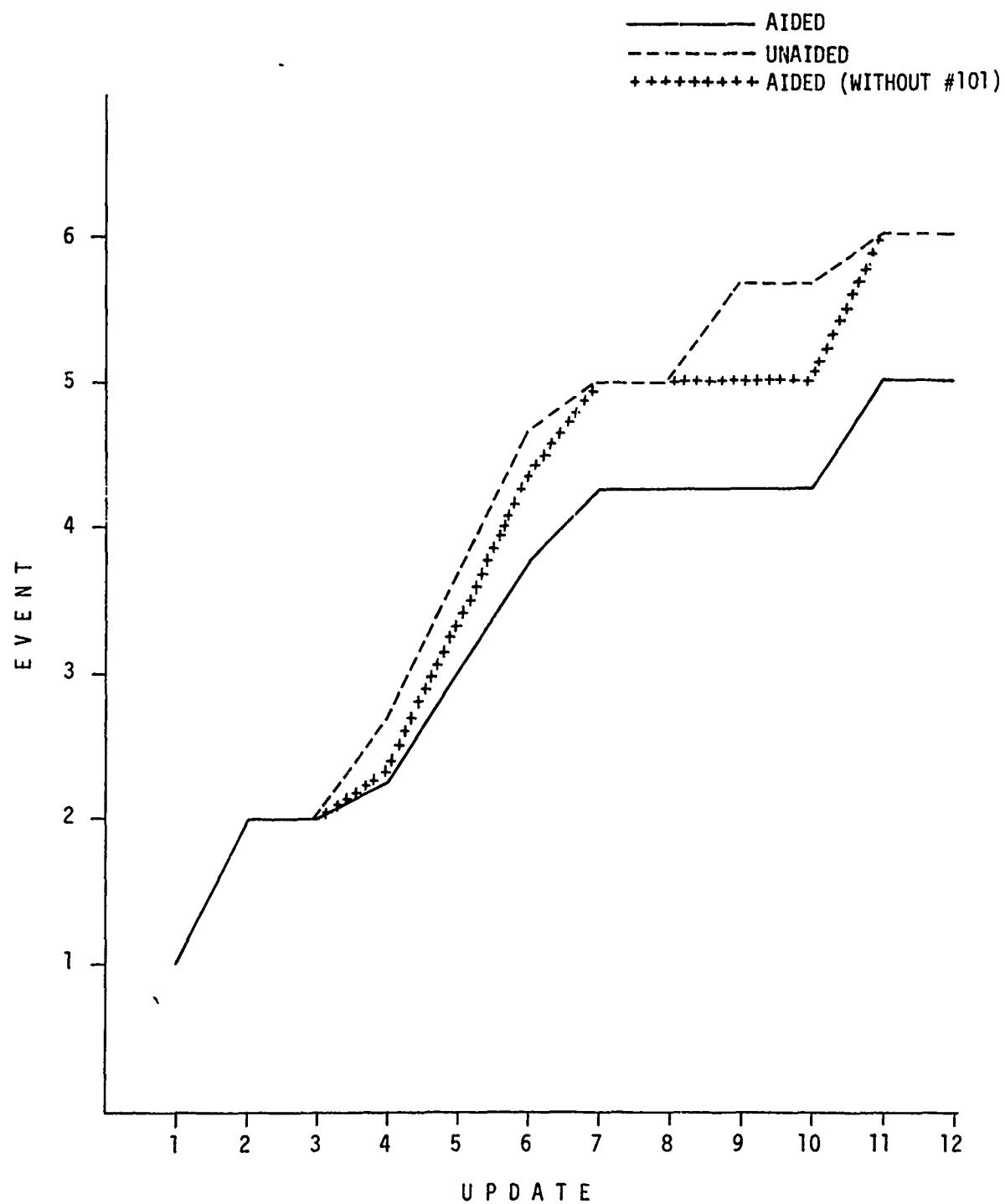
Figure B-50. Event x Update: Low Abstract (Aided and Unaided)
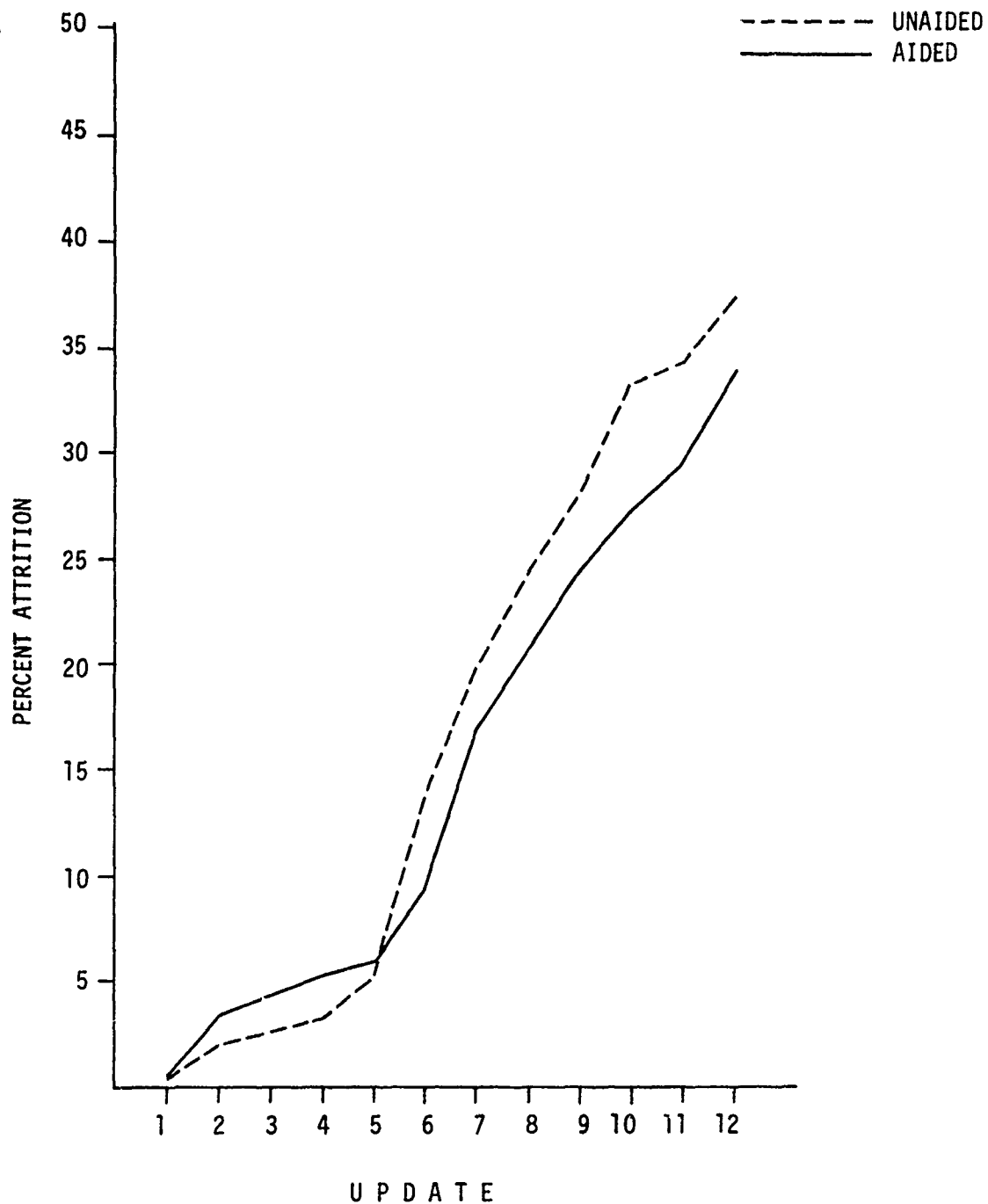
Figure B-51. Friendly Force Attrition x Update:
Aided/Unaided
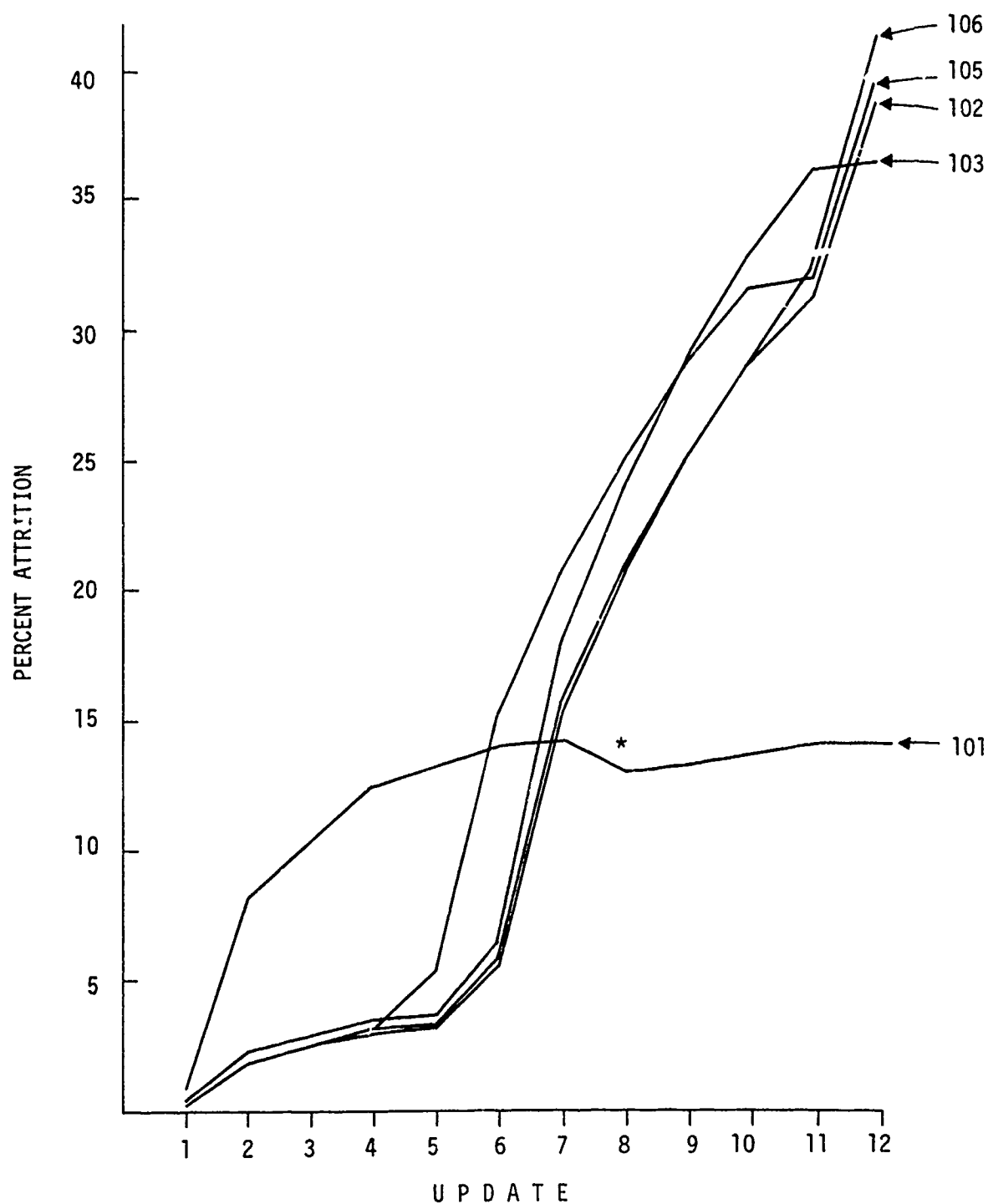
Figure B-52. Friendly Force Attrition: Aided Subjects
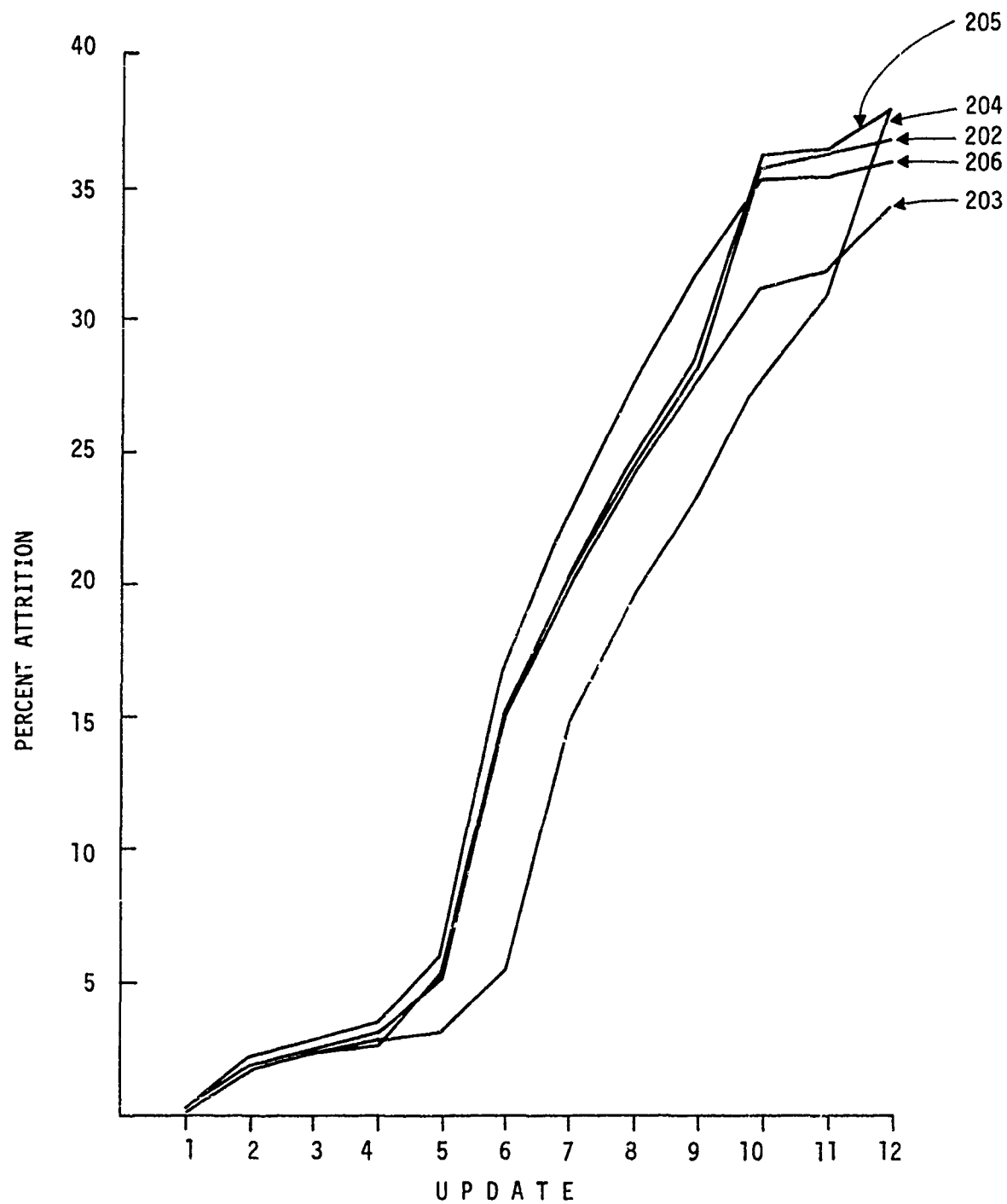
Figure B-53. Friendly Force Attrition: Unaided Subjects
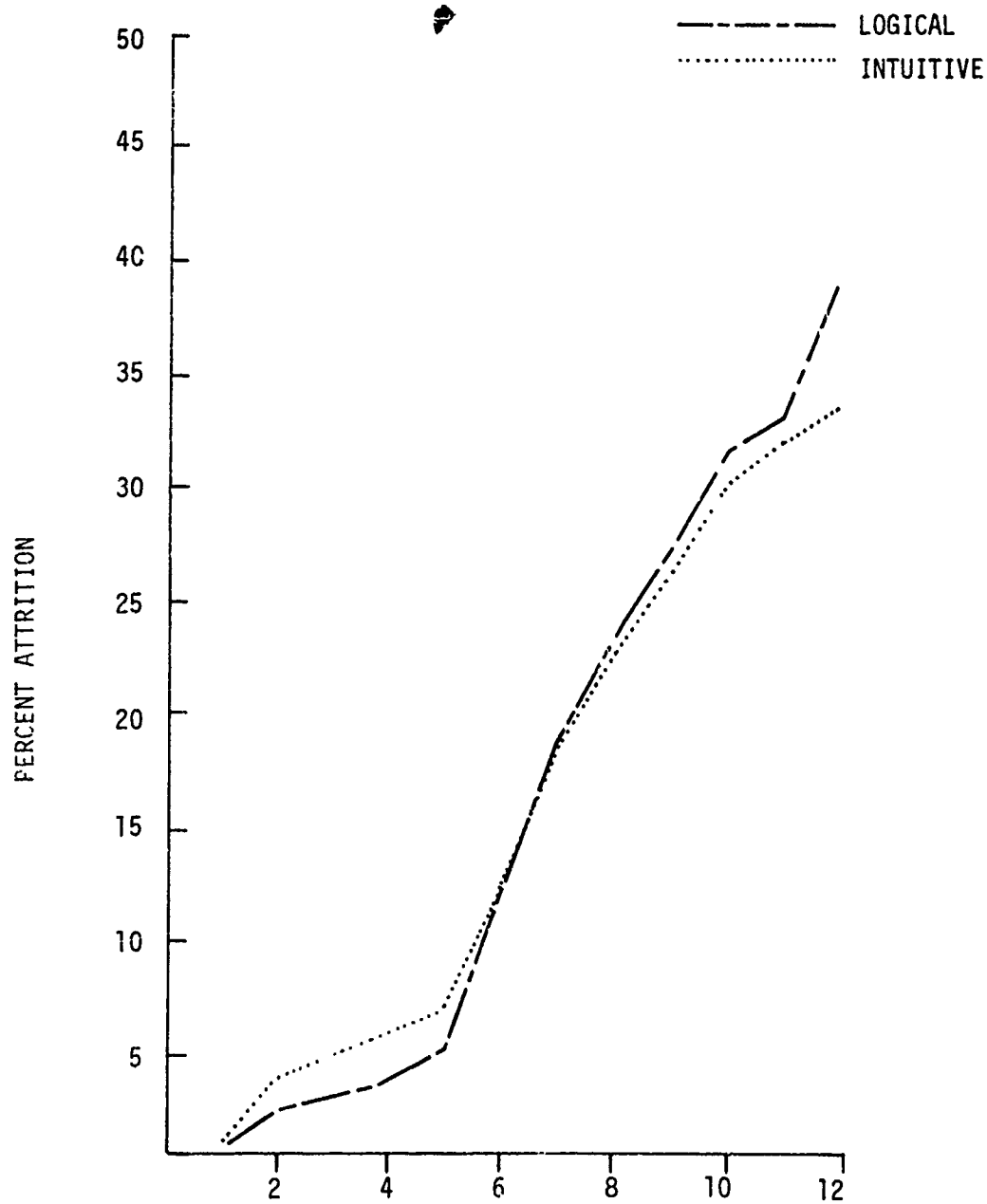
Figure B-54.   Friendly Force Attrition: Logical/Intuitive
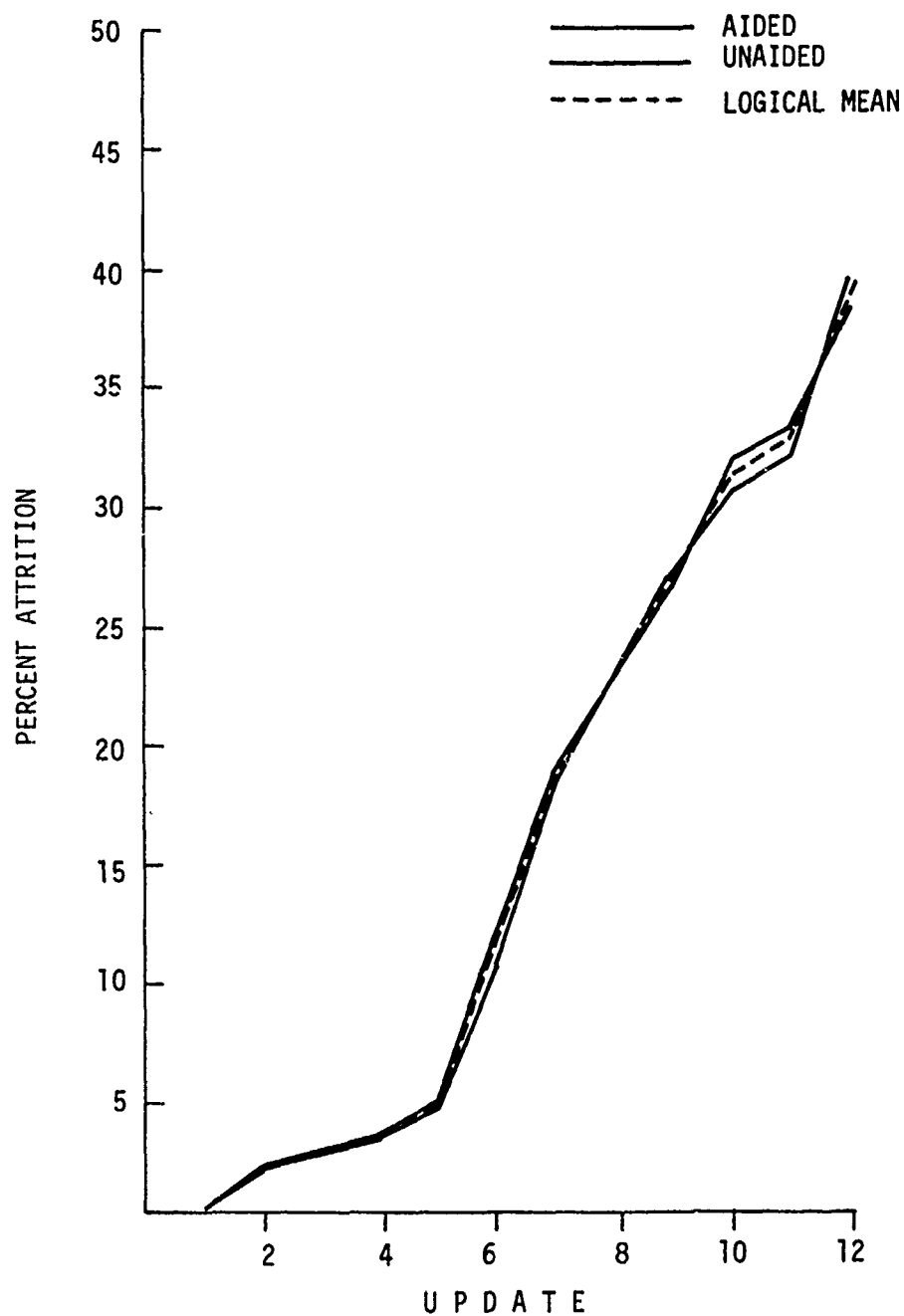
Figure B-55. Friendly Force Attrition: Logical
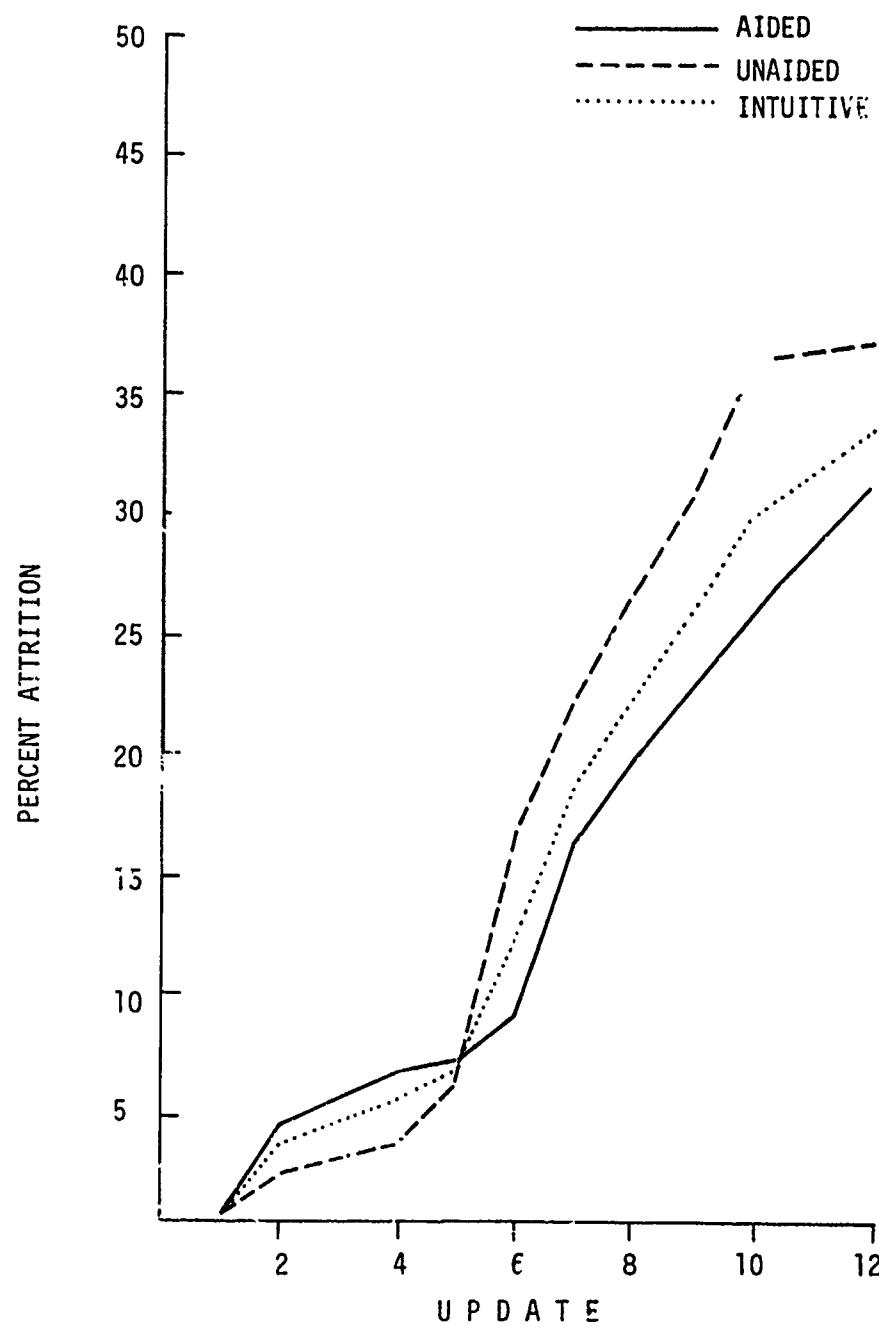
Figure B-56. Friendly Force Attrition: Intuitive
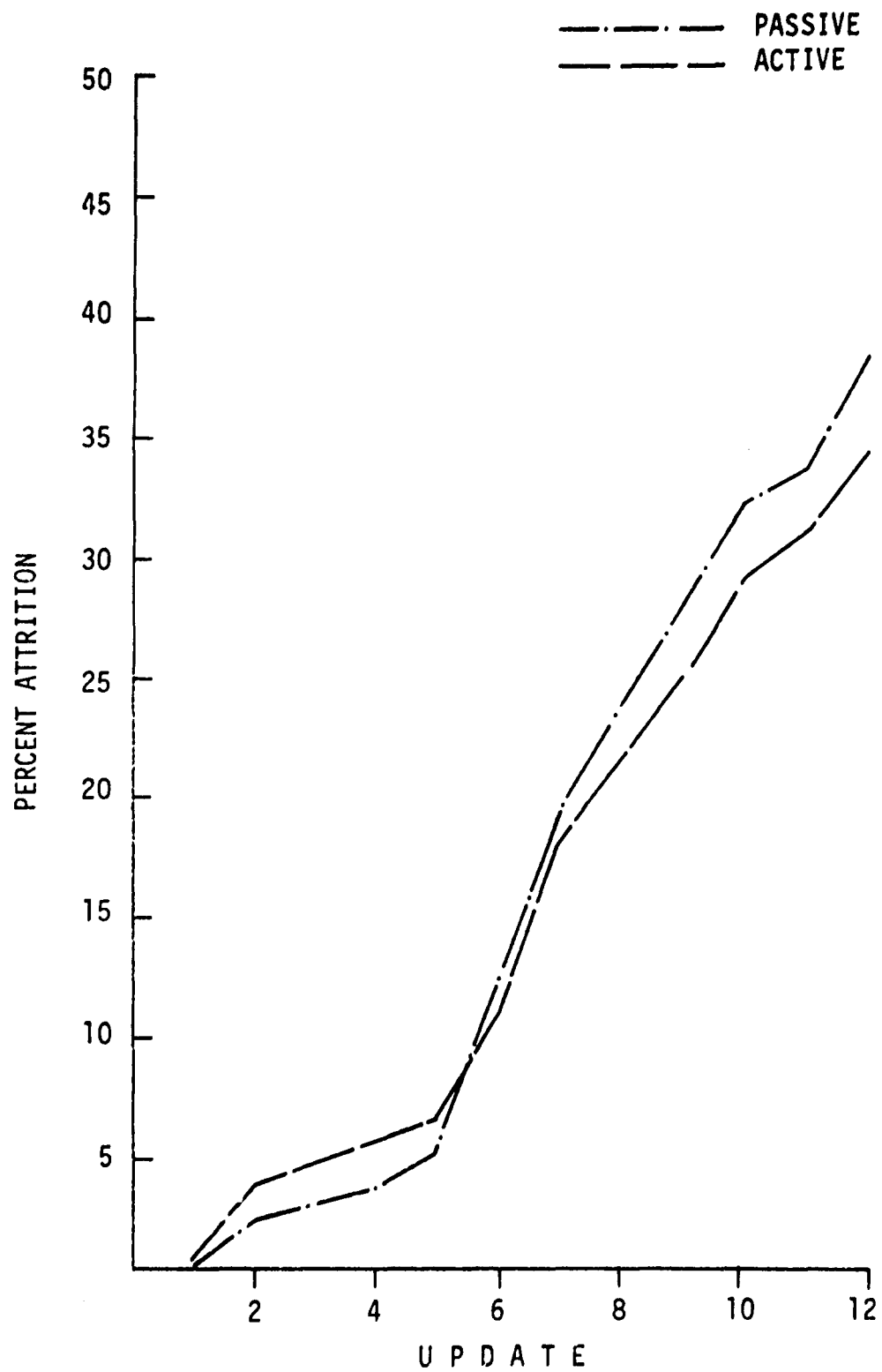
Figure B-57. Friendly Force Attrition: Active/Passive
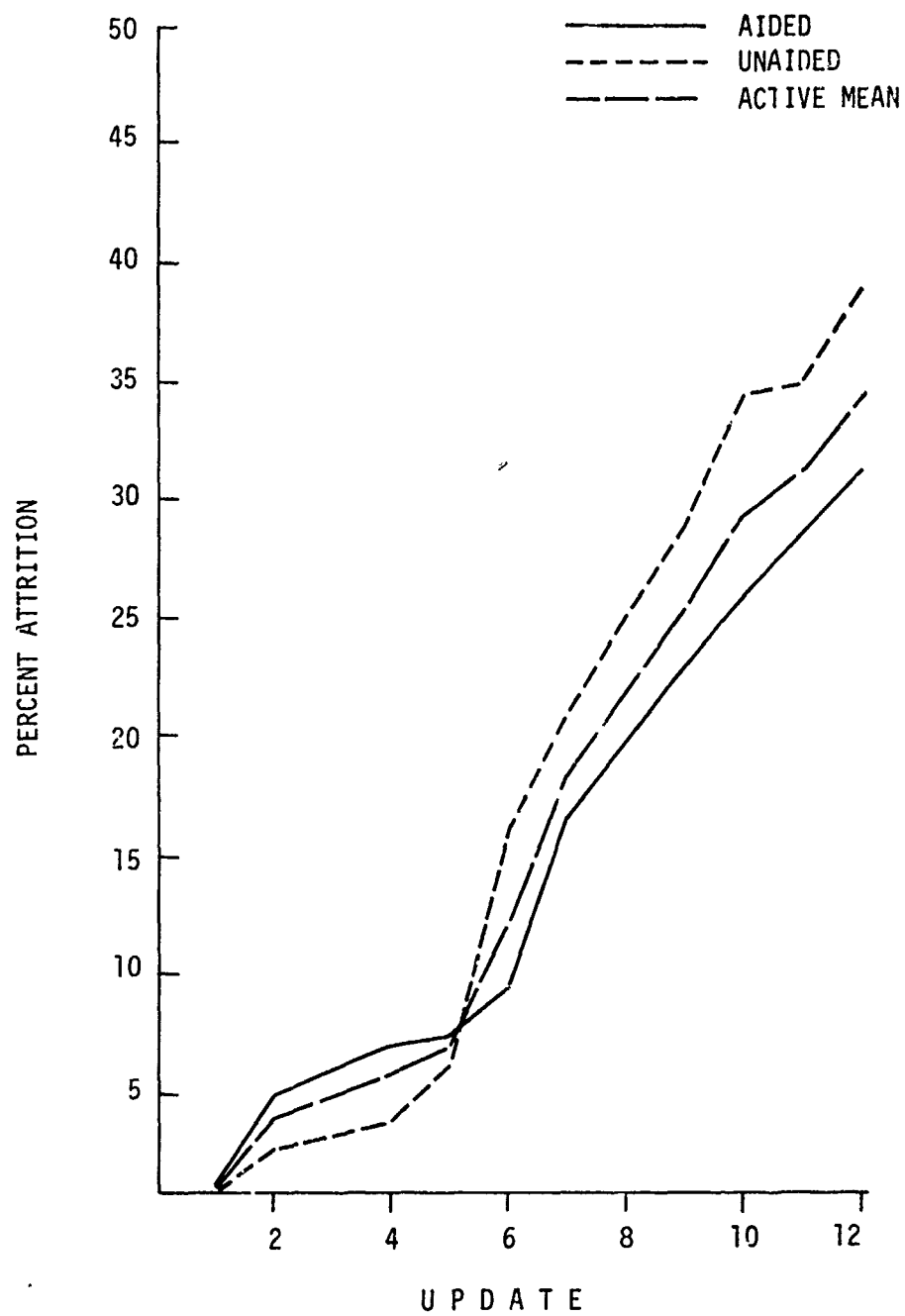
Figure B-58. Friendly Force Attrition: Active
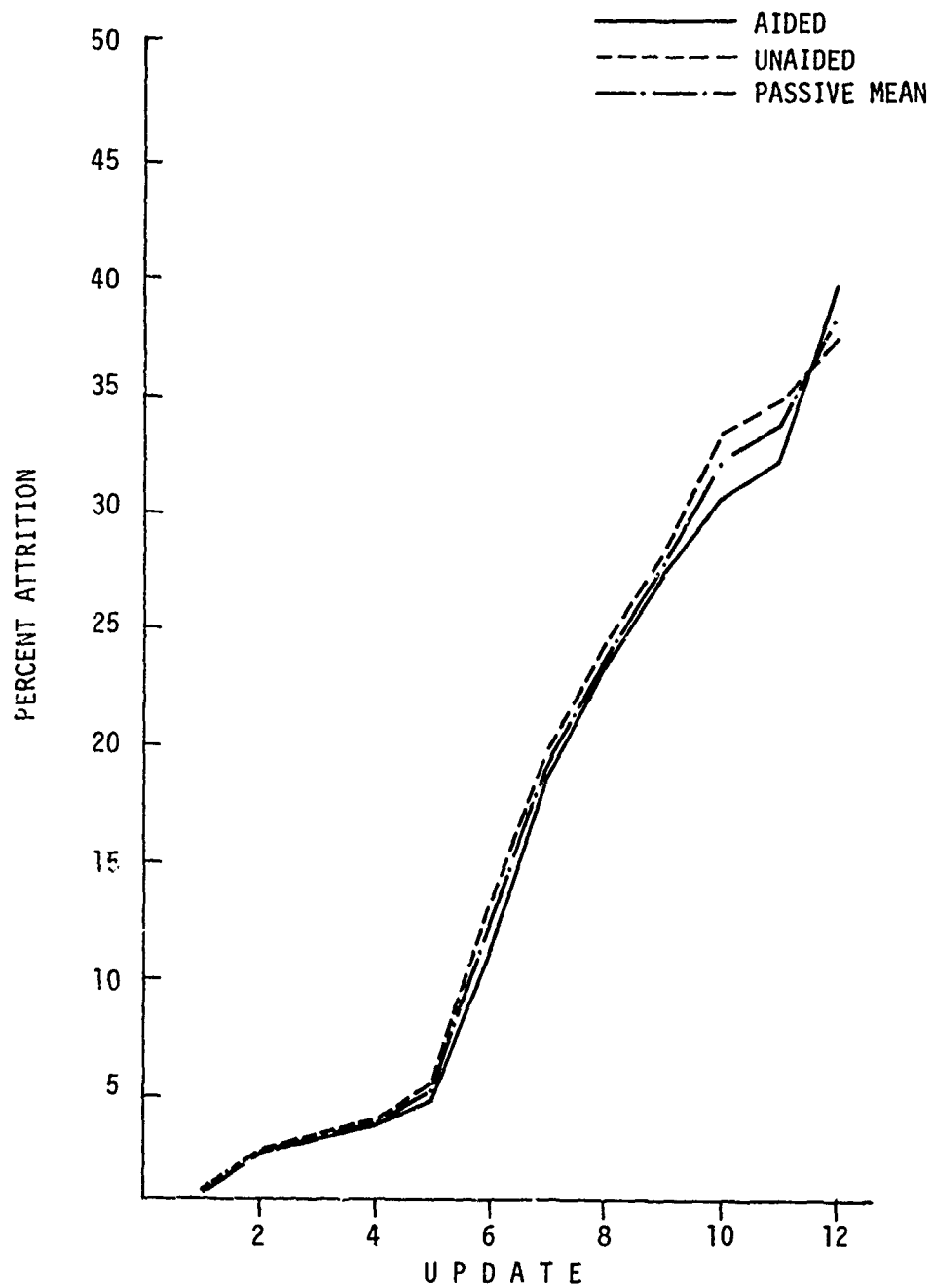
Figure B-59. Friendly Force Attrition: Passive
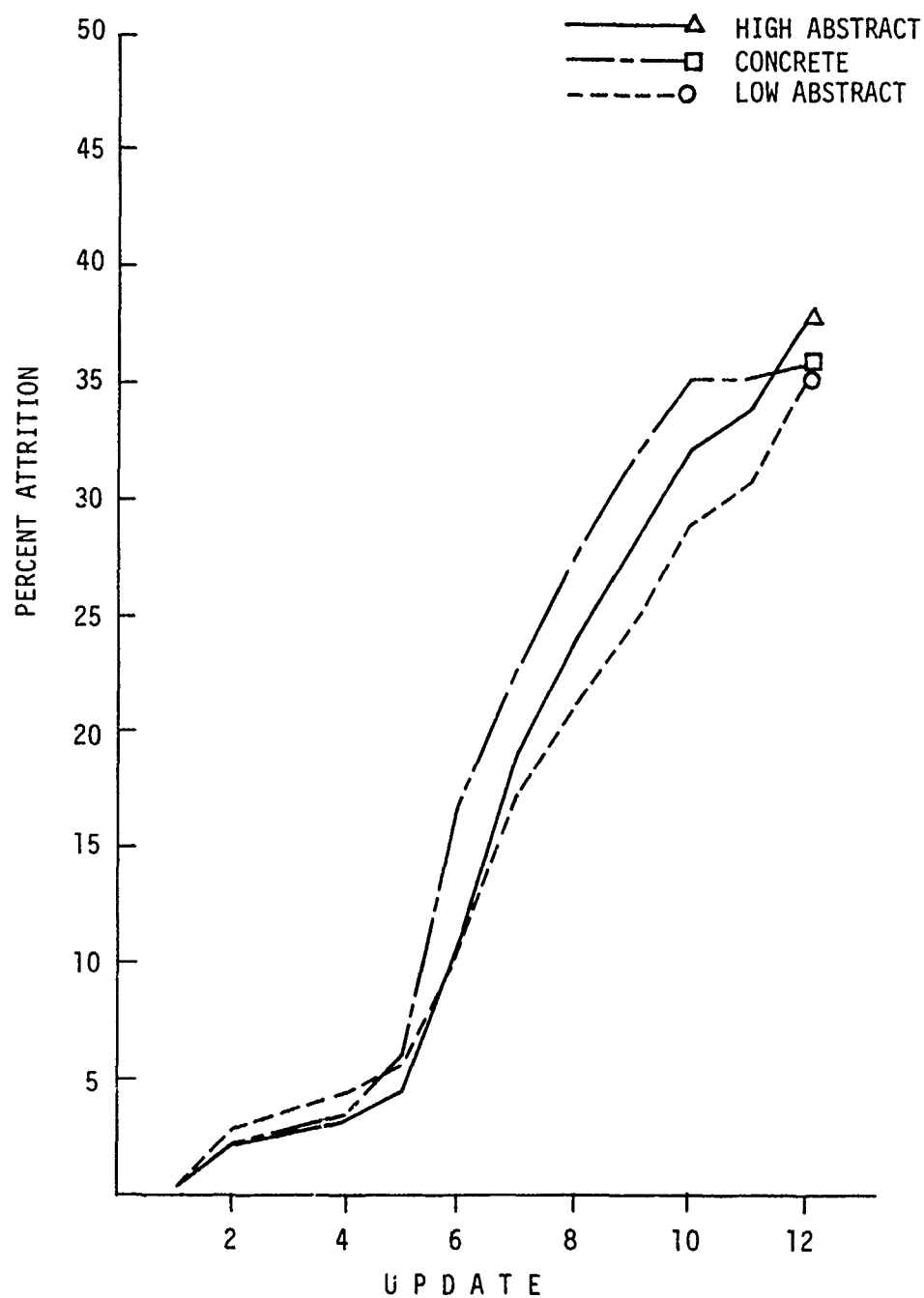
Figure B-60. Friendly Force Attrition: High Abscract/Low Abstract/Concrete
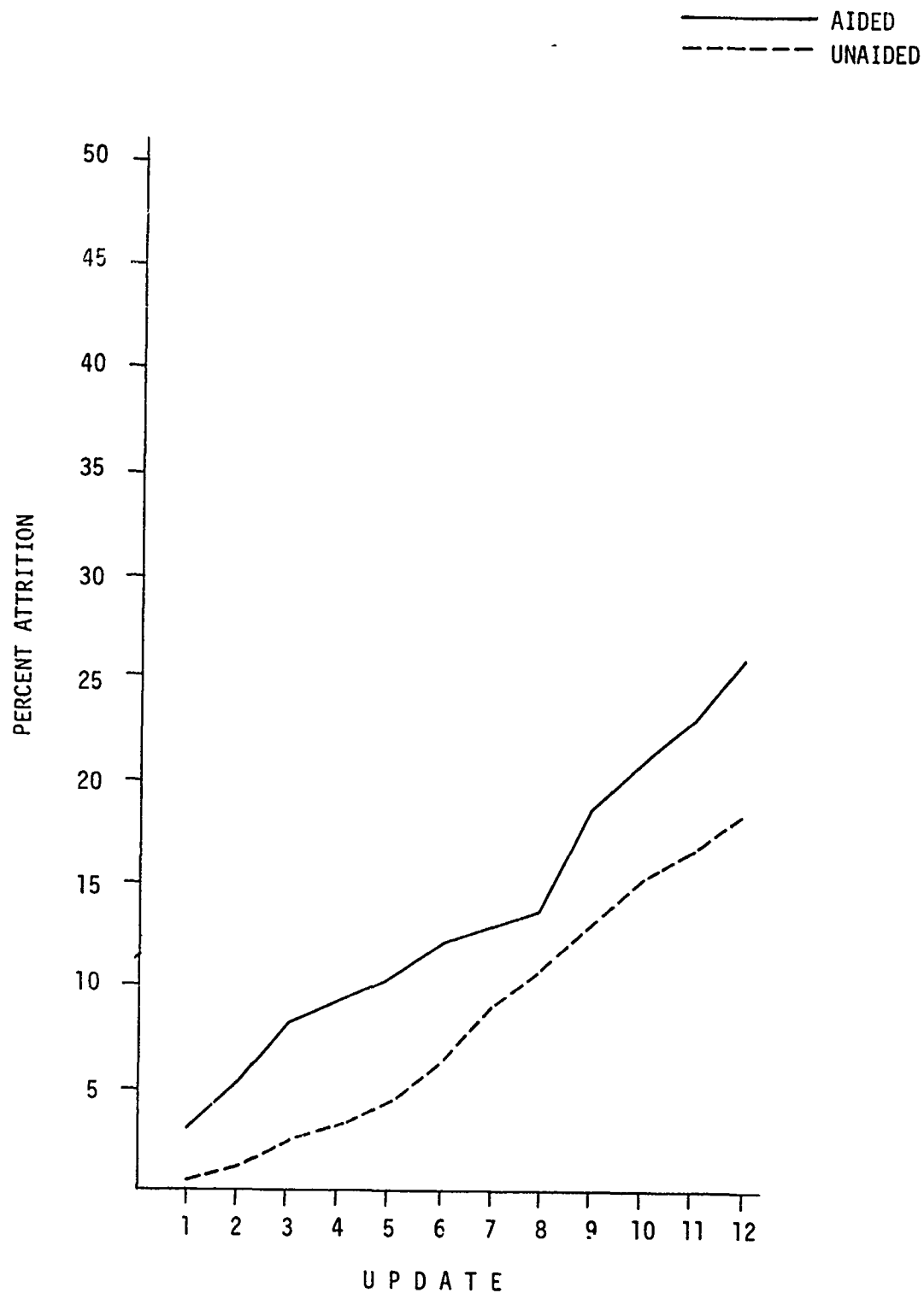
Figure B-61. Enemy Force Attrition x Update: Aided/Unaided
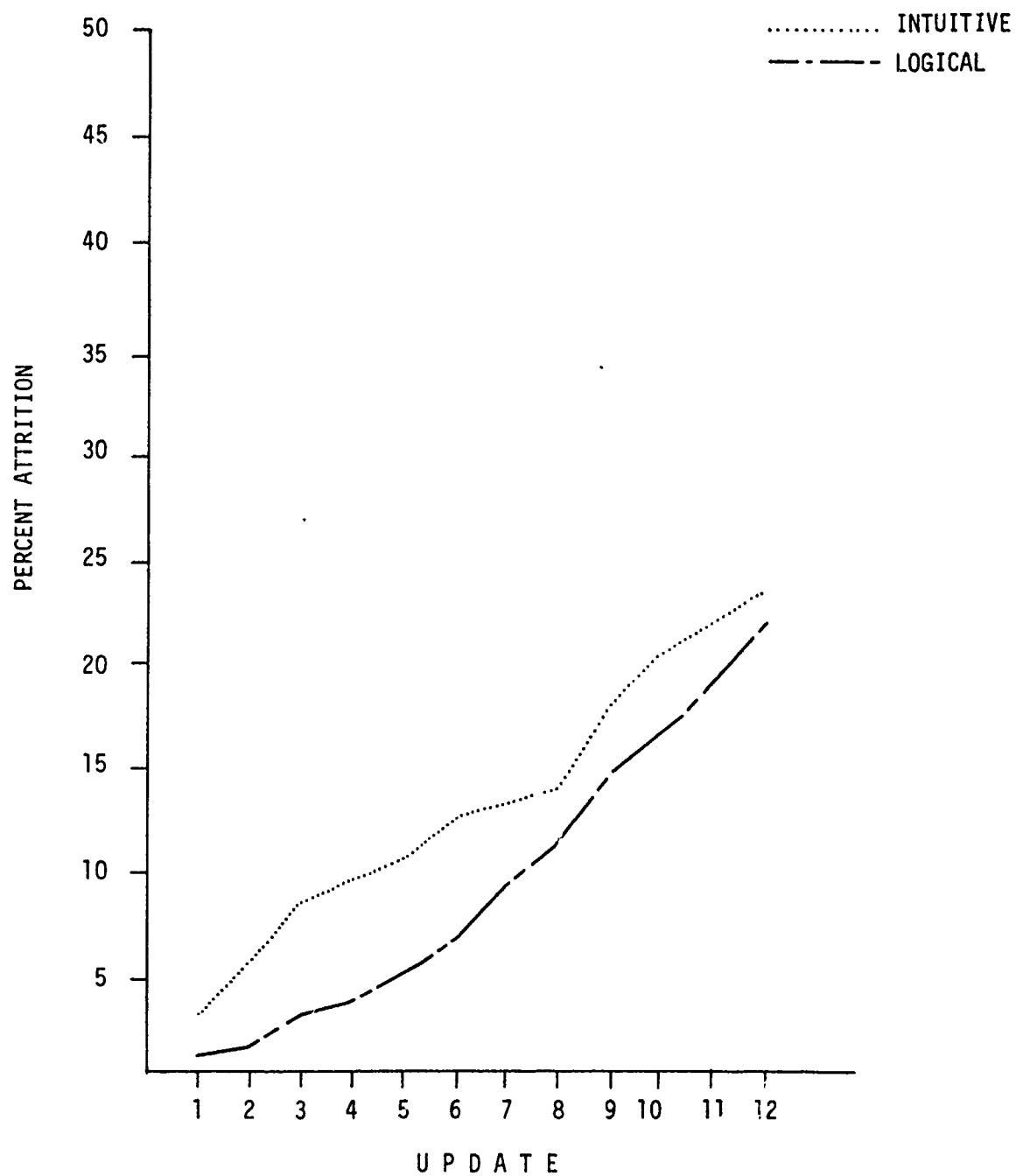
Figure B-62. Enemy Force Attrition: Logical/Intuitive
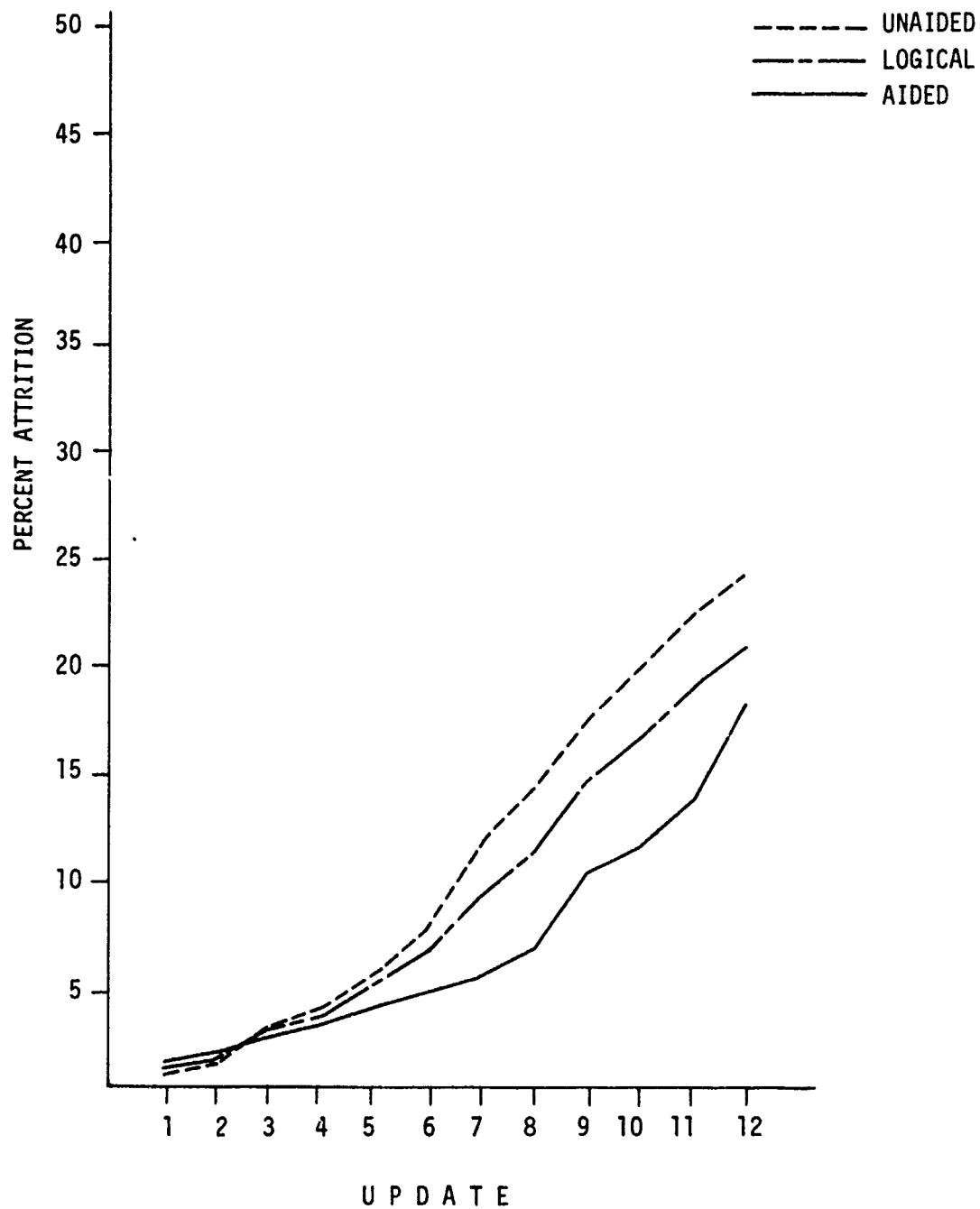
Figure B-63. Enemy Force Attrition: Logical (Aided and Unaided)
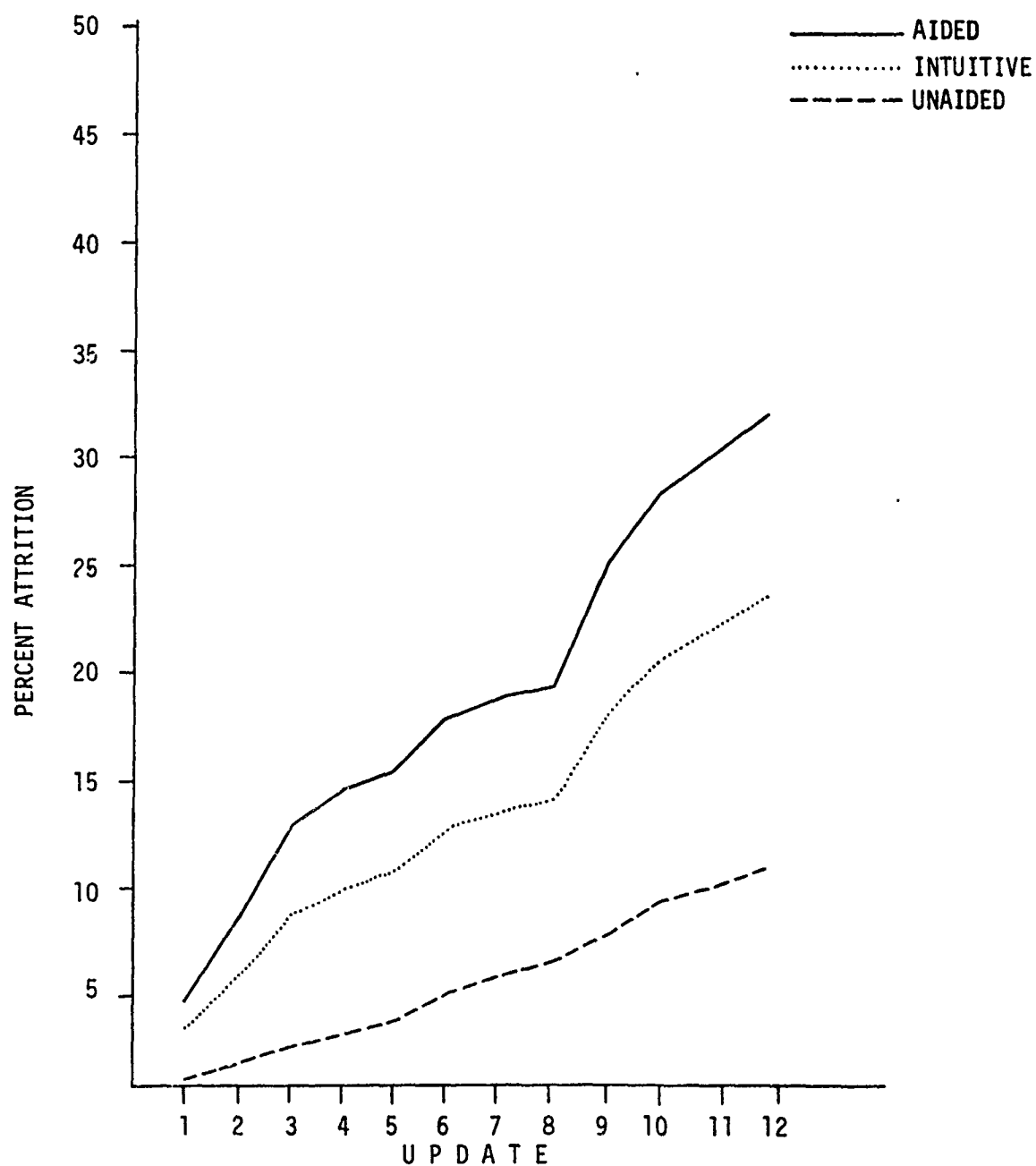
Figure B-64. Enemy Force Attrition: Intuitive (Aided and Unaided)
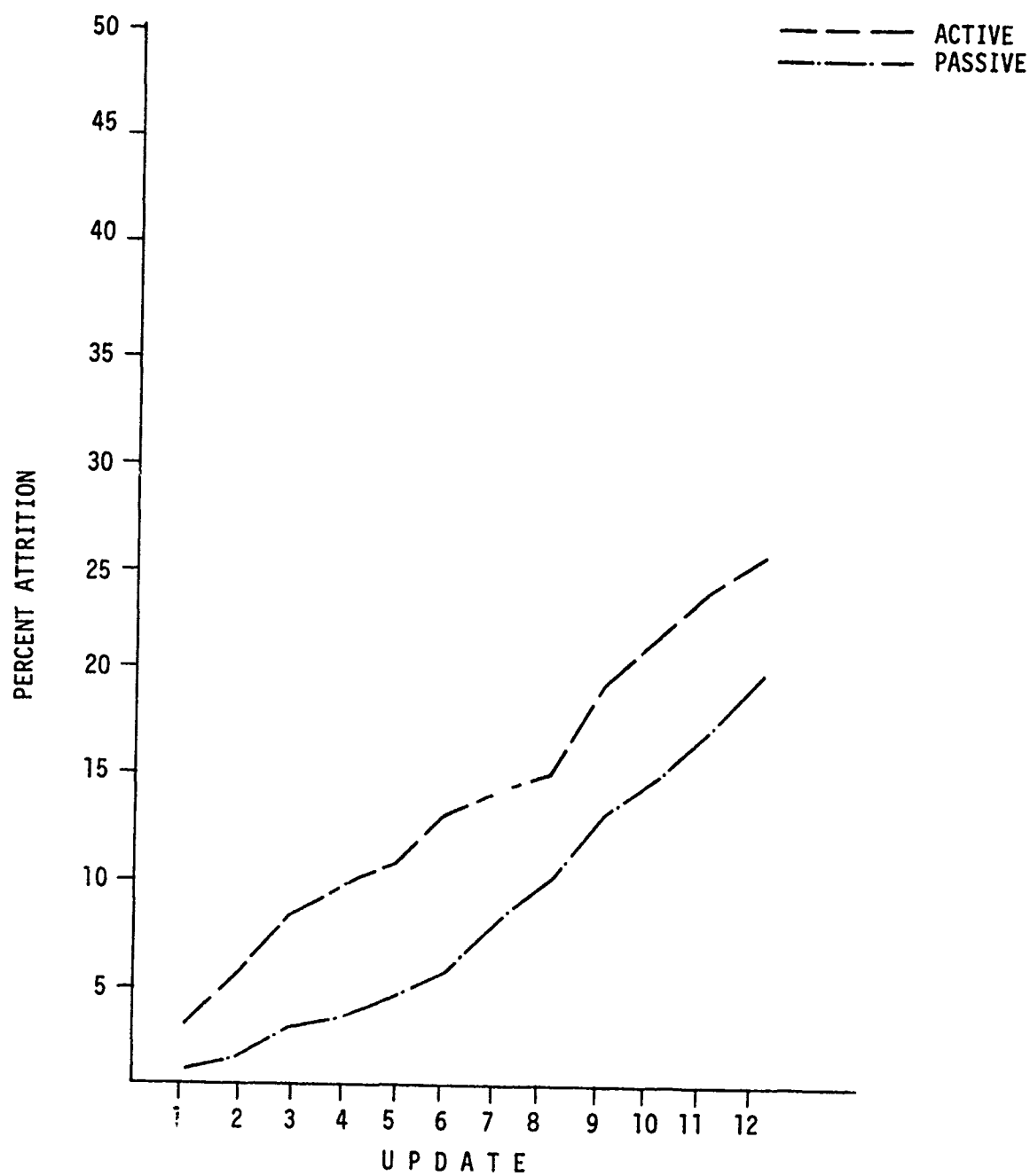
Figure B-65. Enemy Force Attrition: Active/Passive
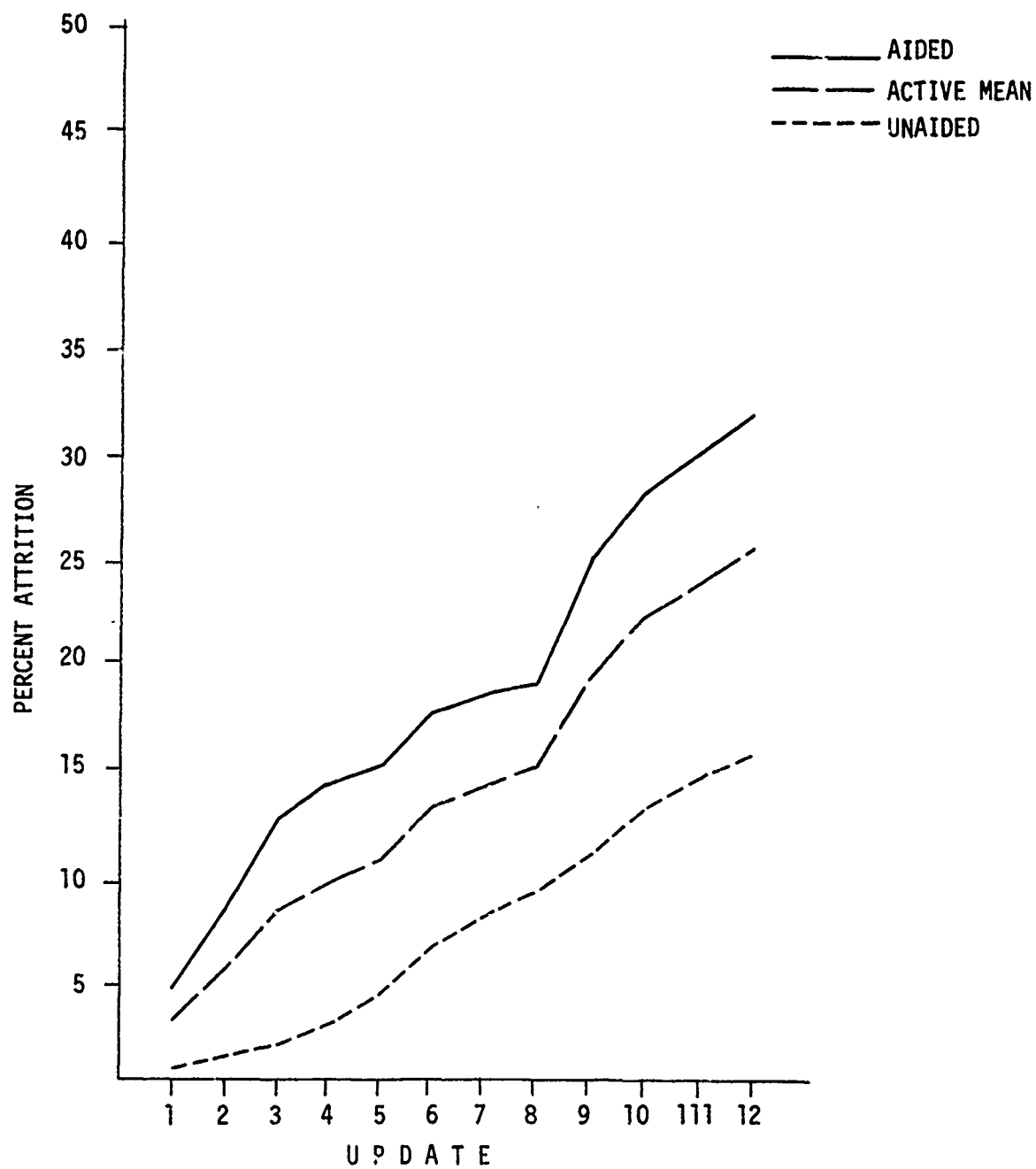
Figure B-66. Enemy Force Attrition: Active (Aided and Unaided)
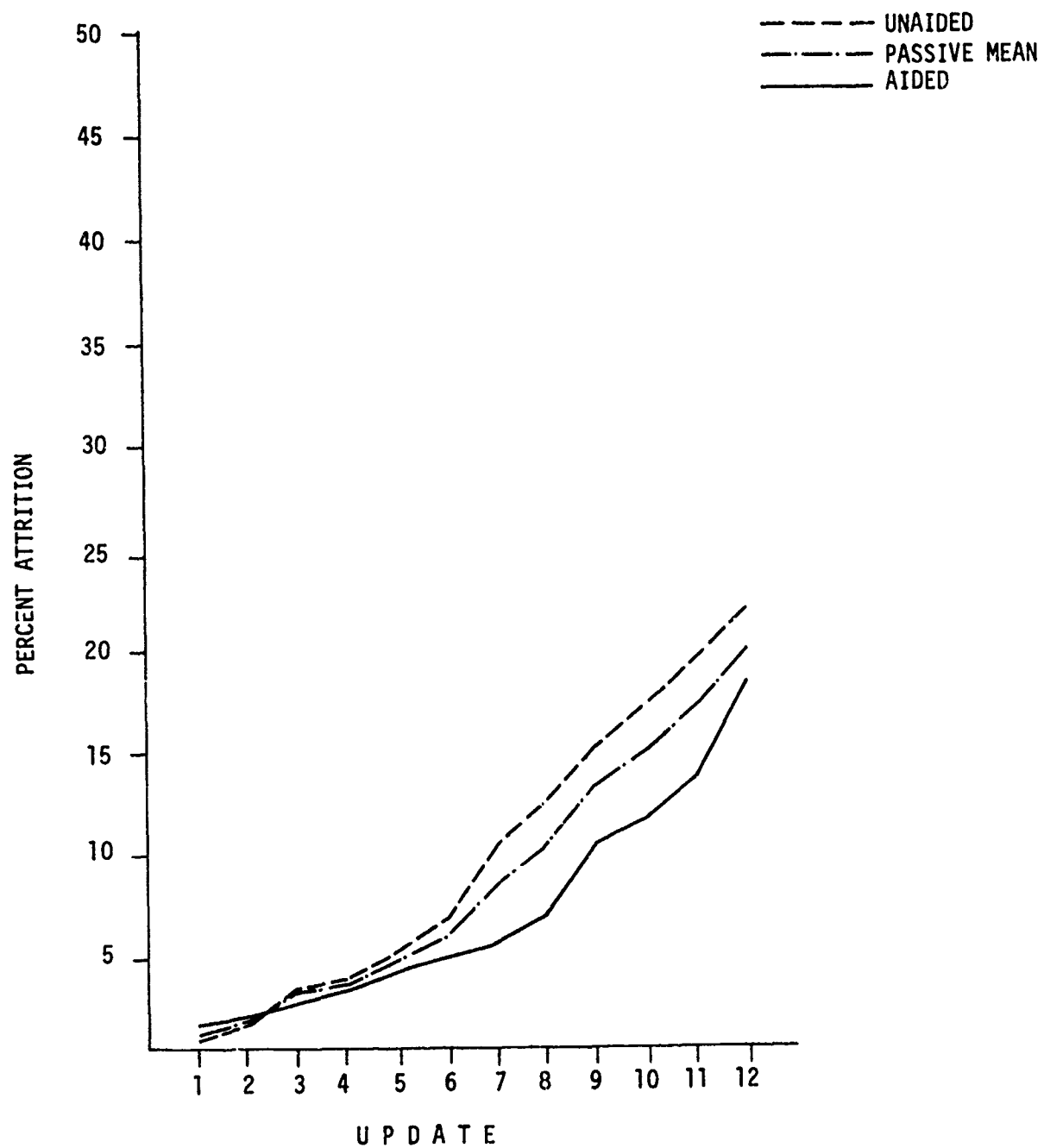
Figure B-67. Enemy Force Attrition: Passive (Aided and Unaided)
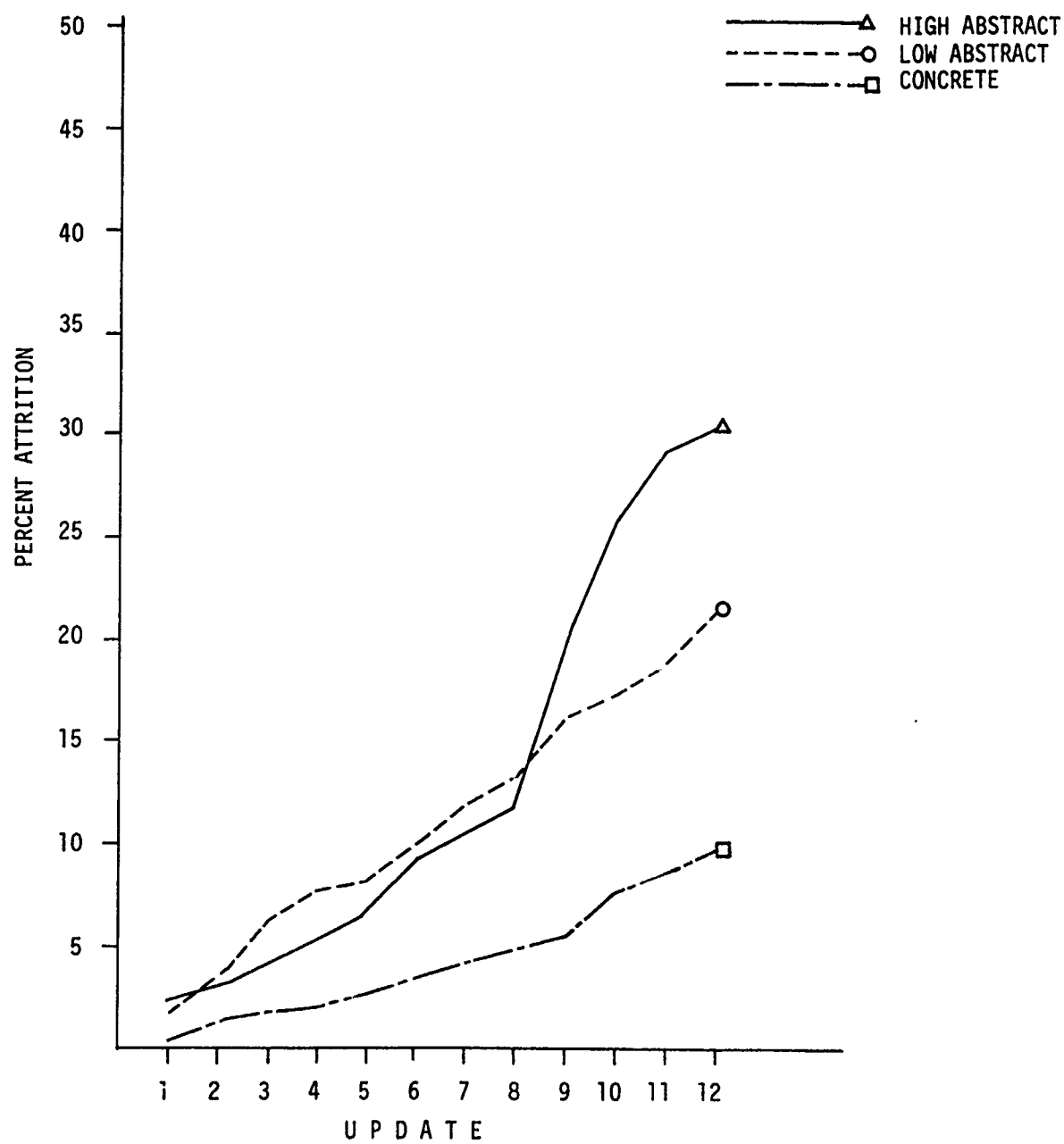
Figure B-68. Enemy Force Attrition: High Abstract/Low Abstract/
Concrete
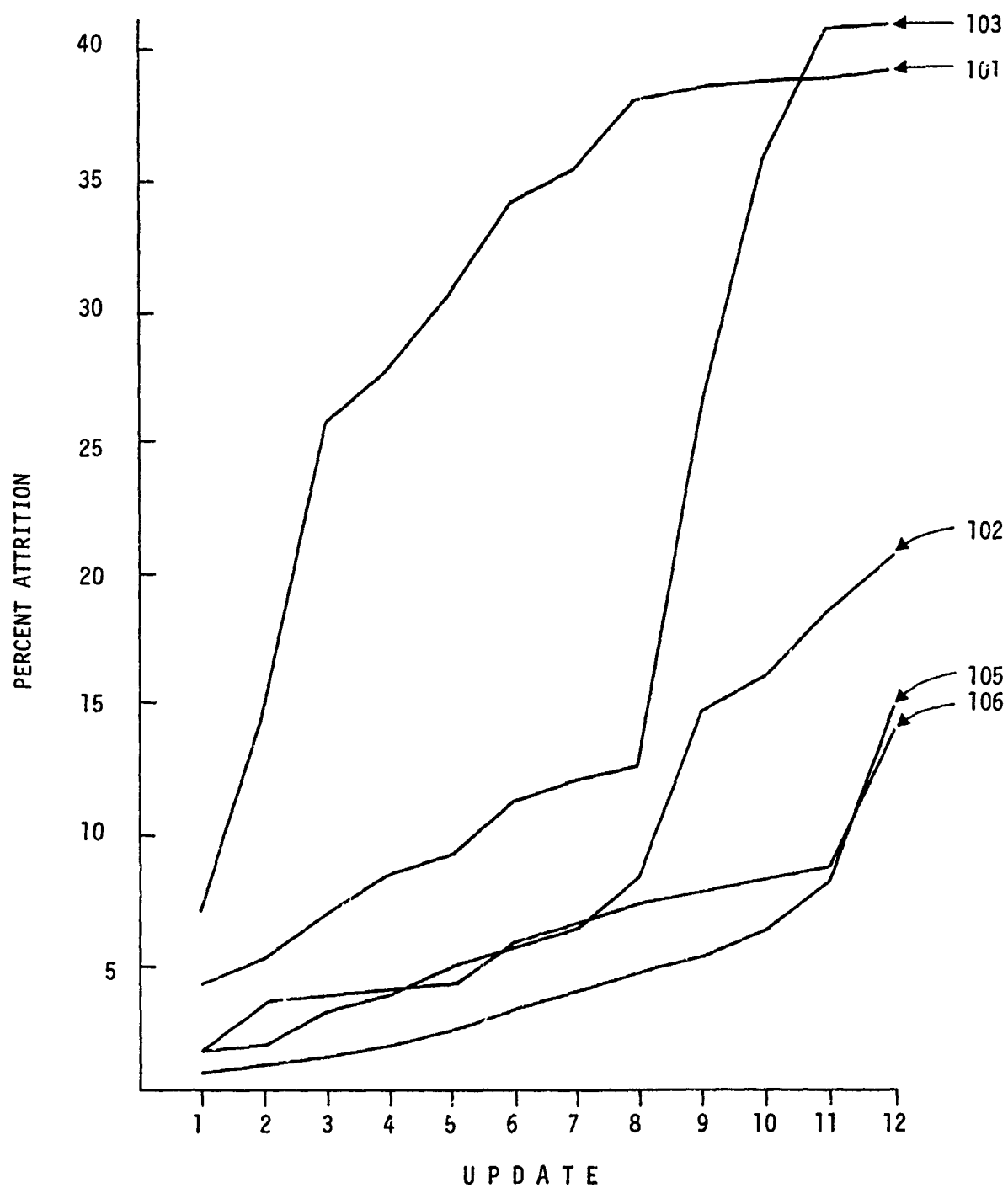
Figure B-69. Enemy Force Attrition.x Update: Aided Consultants
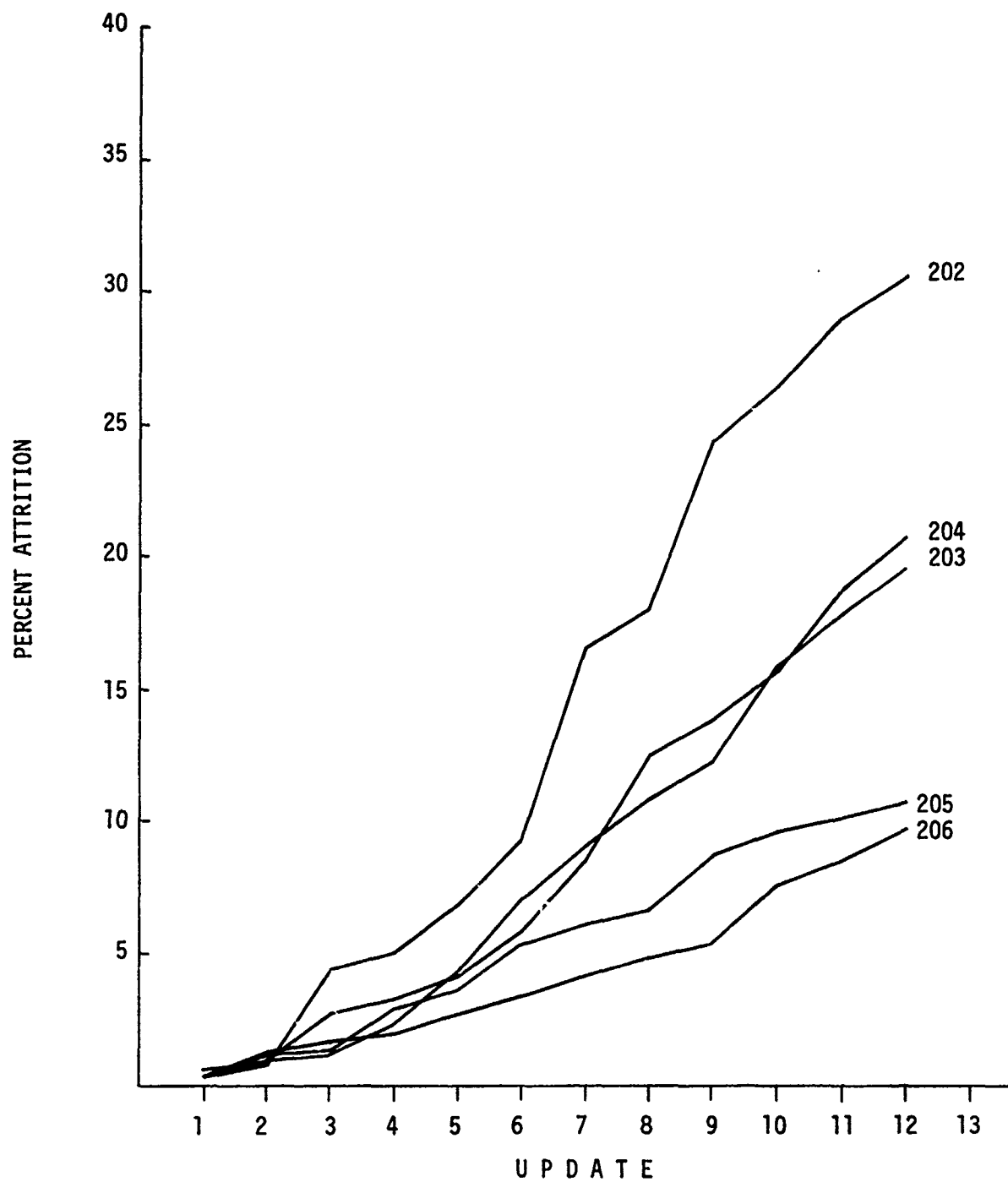
Figure B-70. Enemy Force Attrition x Update: Unaided Consultants
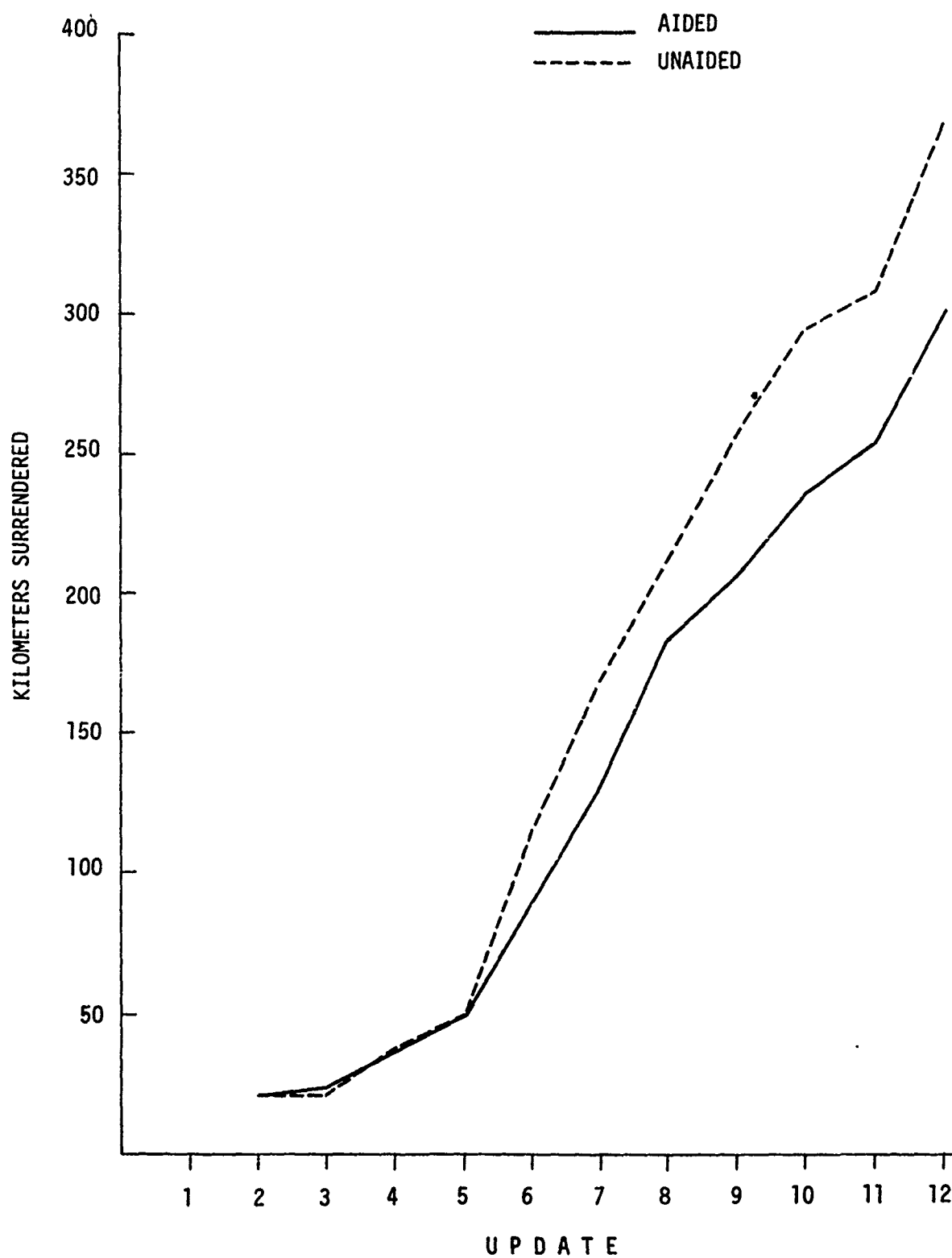
Figure B-71. Distance Surrendered x Update: Aided/Unaided
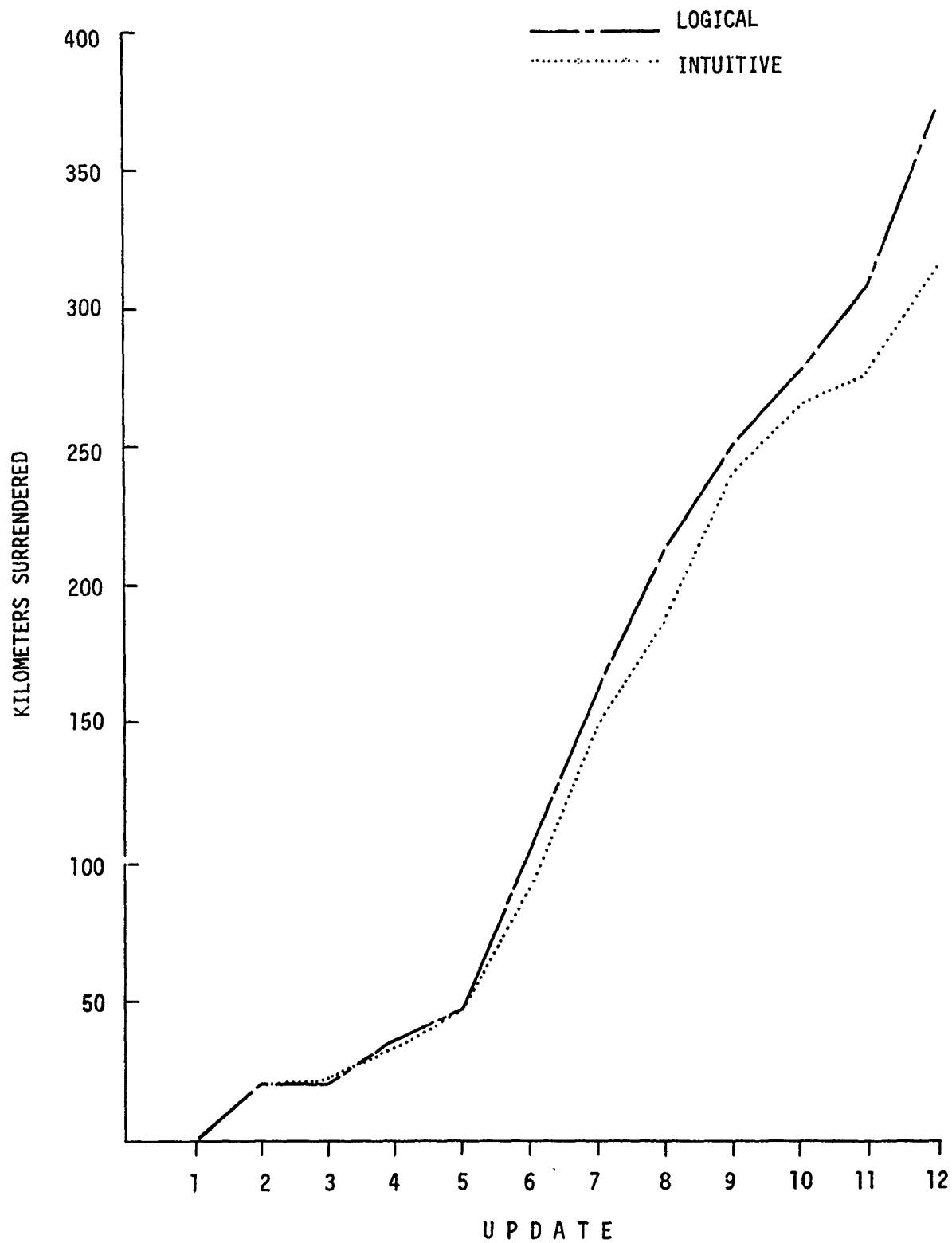
Figure B-72. Distance Surrendered x Update: Logical/Intuitive
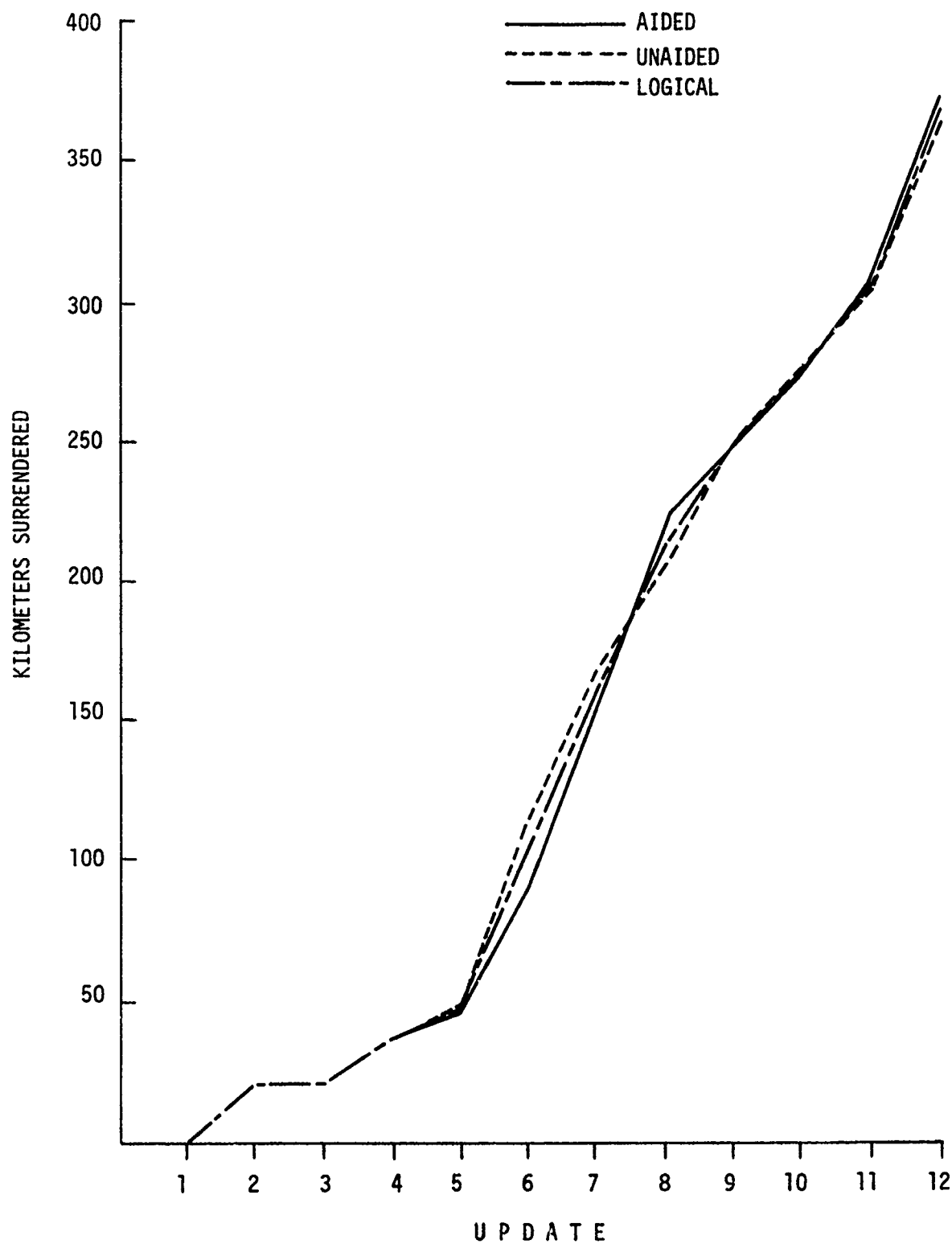
Figure B-73. Distance Surrendered x Update: Logical (Aided and Unaided)
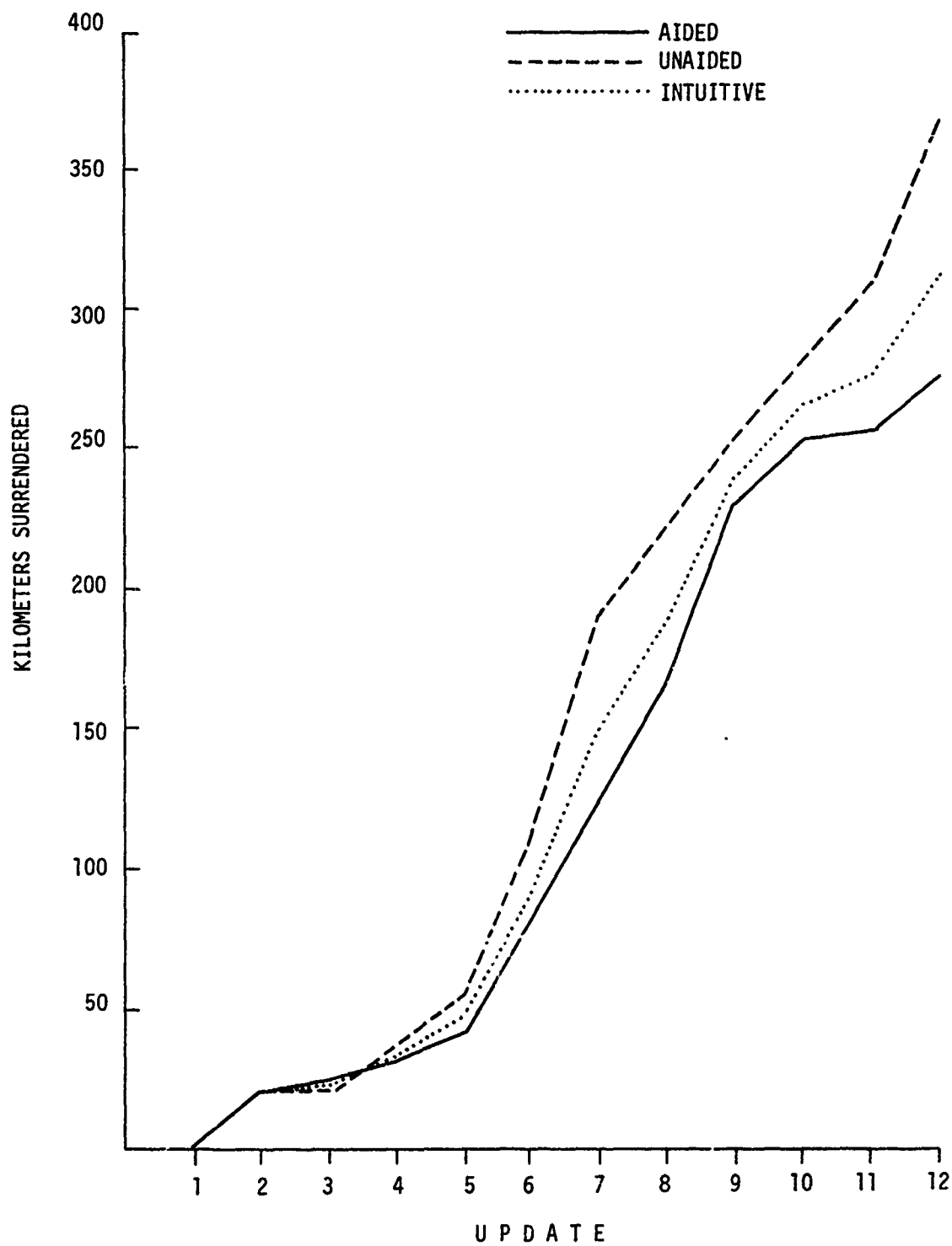
Figure B-74. Distance Surrendered x Update: Intuitive (Aided and Unaided)
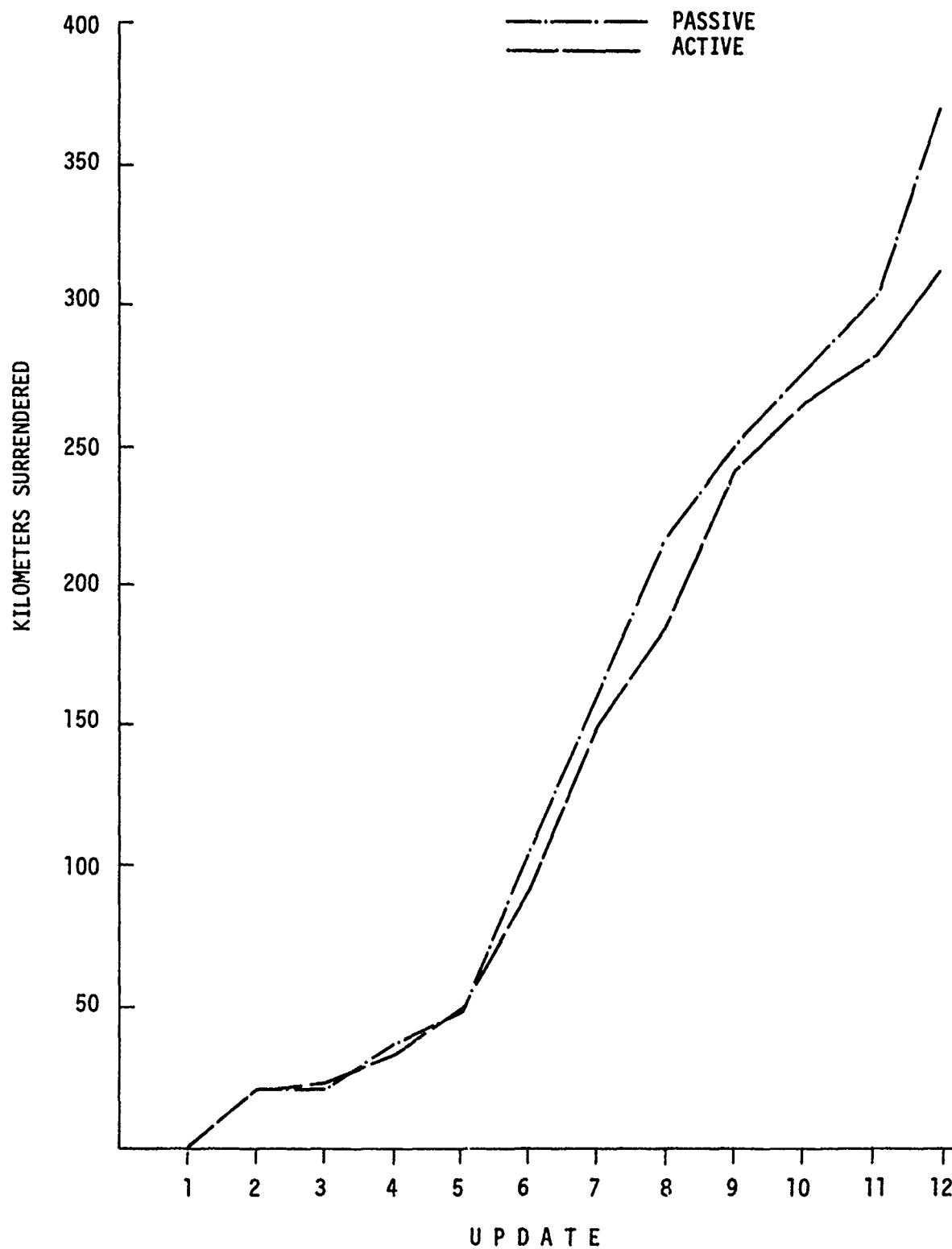
Figure B-75. Distance Surrendered x Update: Active/Passive
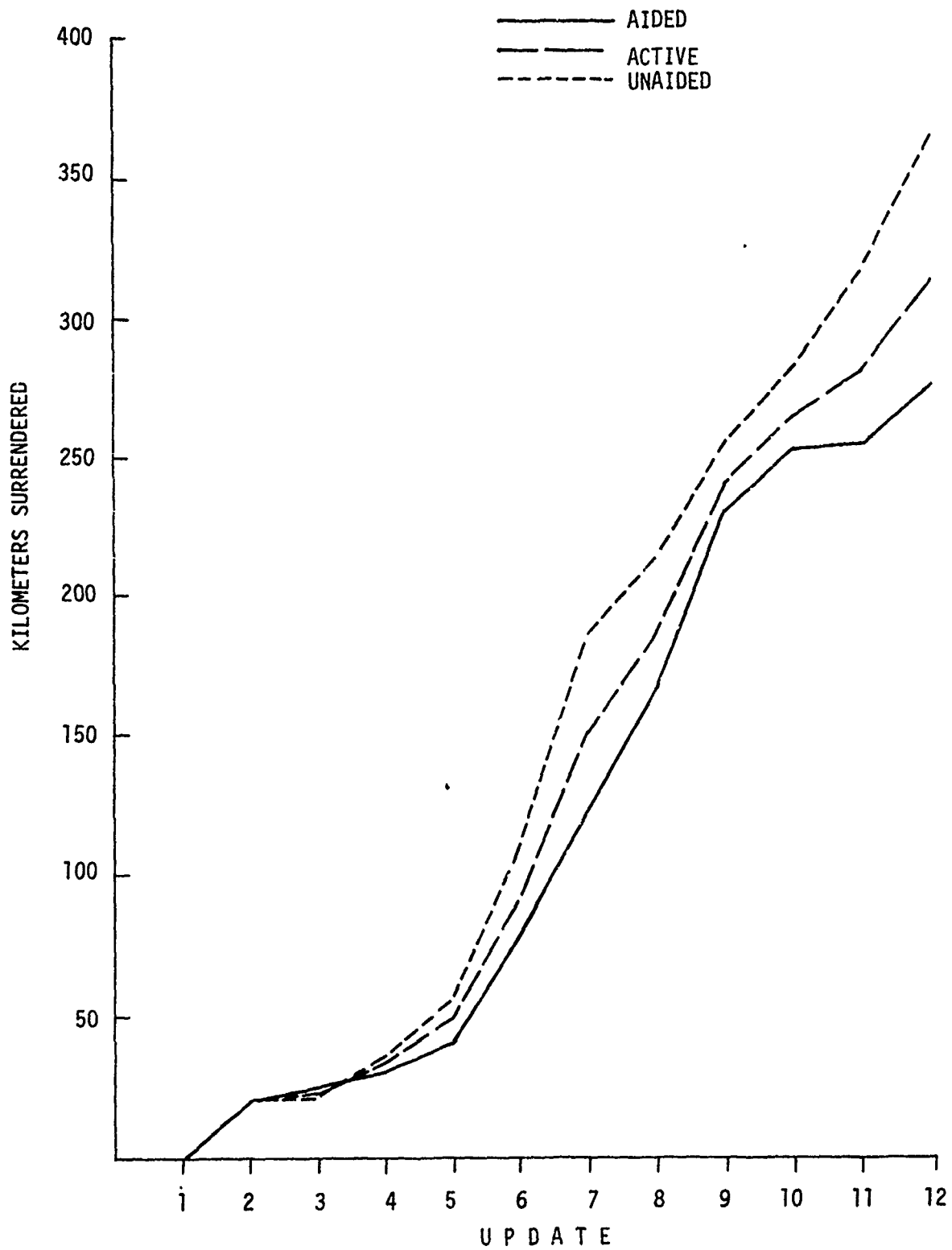
Figure B-76. Distance Surrendered x Update: Active (Aided and Unaided)
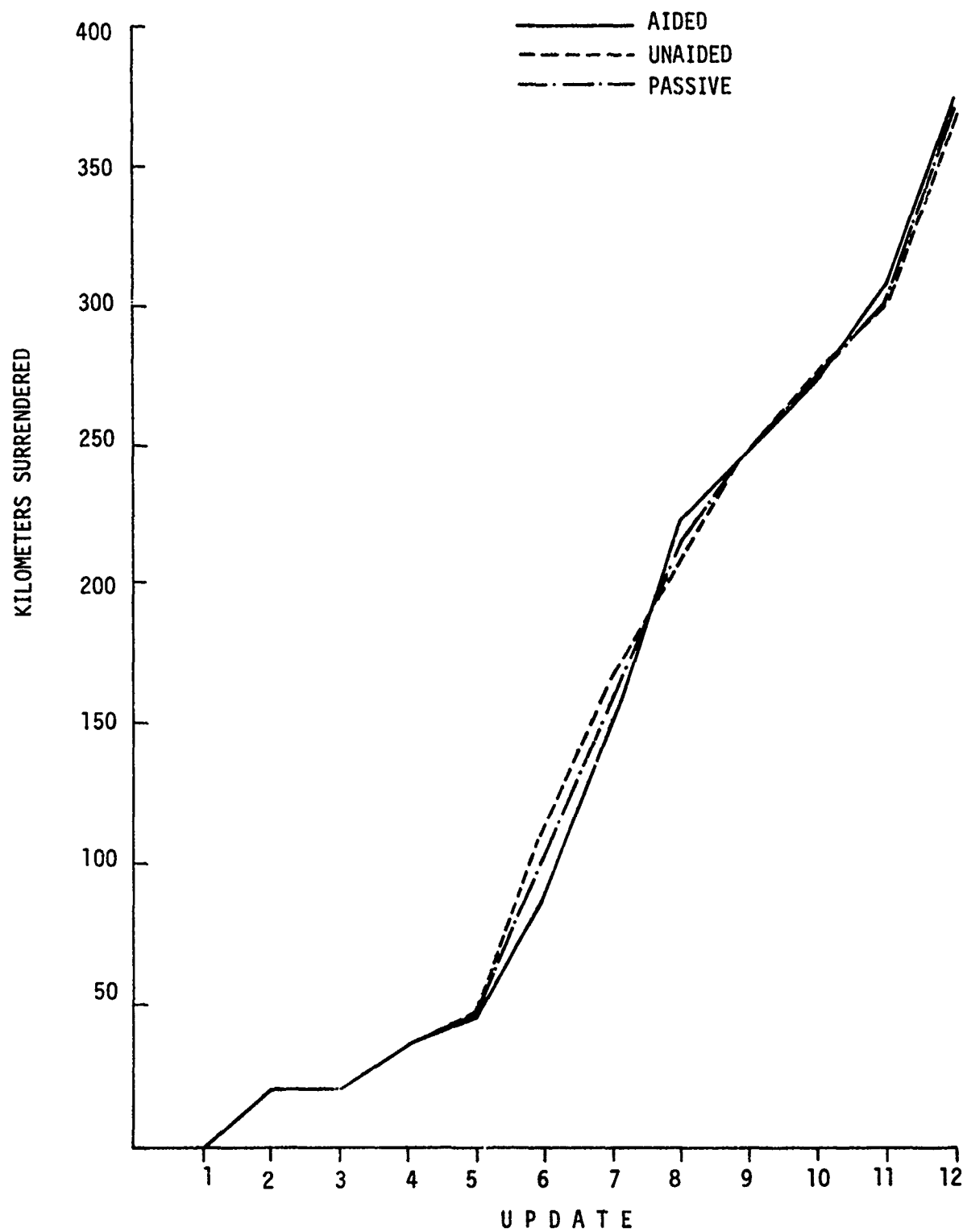
Figure B-77. Distance Surrendered: Passive (Aided and Unaided)
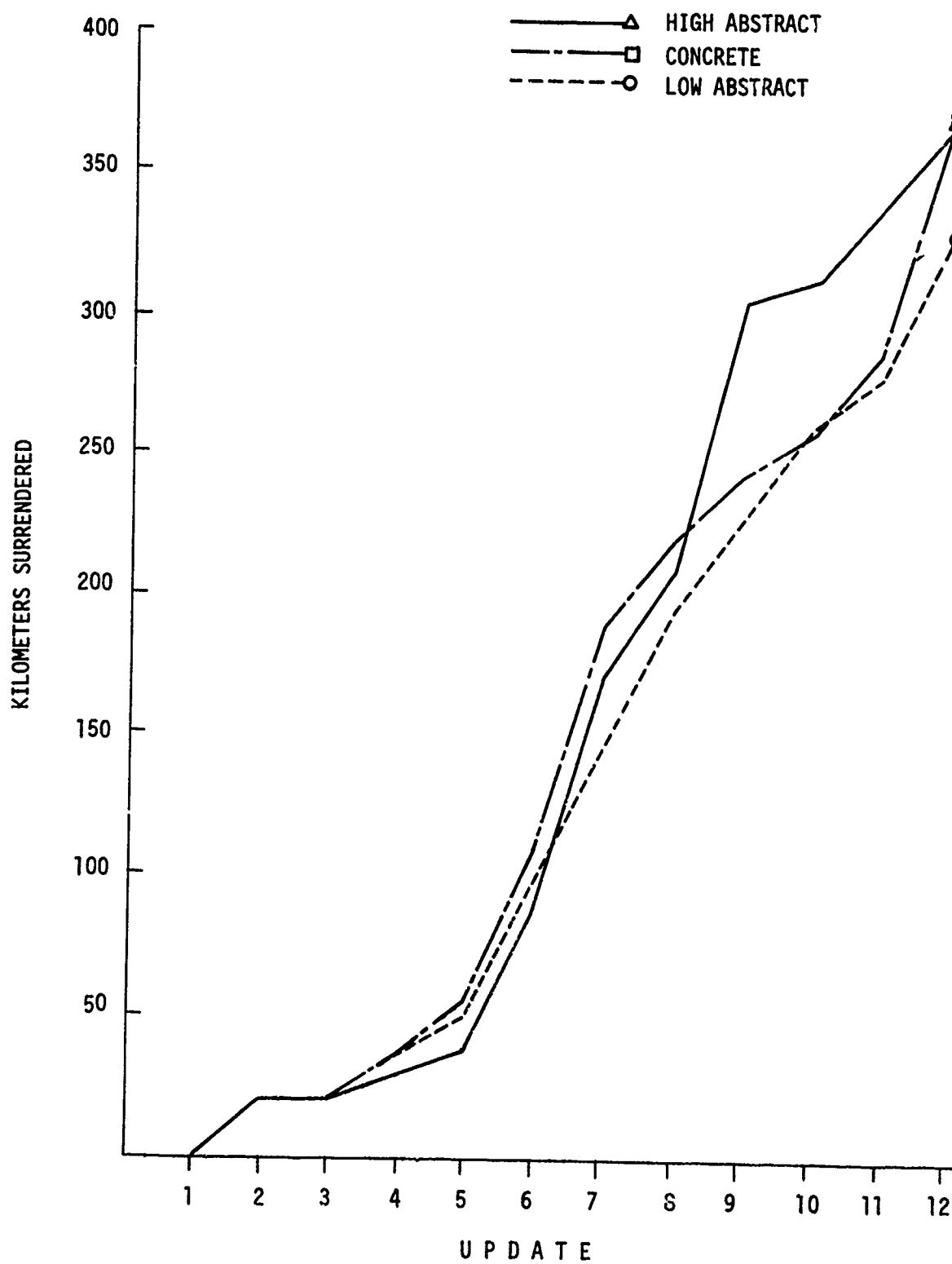
Figure B-78. Distance Surrendered x Update: High Abstract/Low Abstract/
Concrete
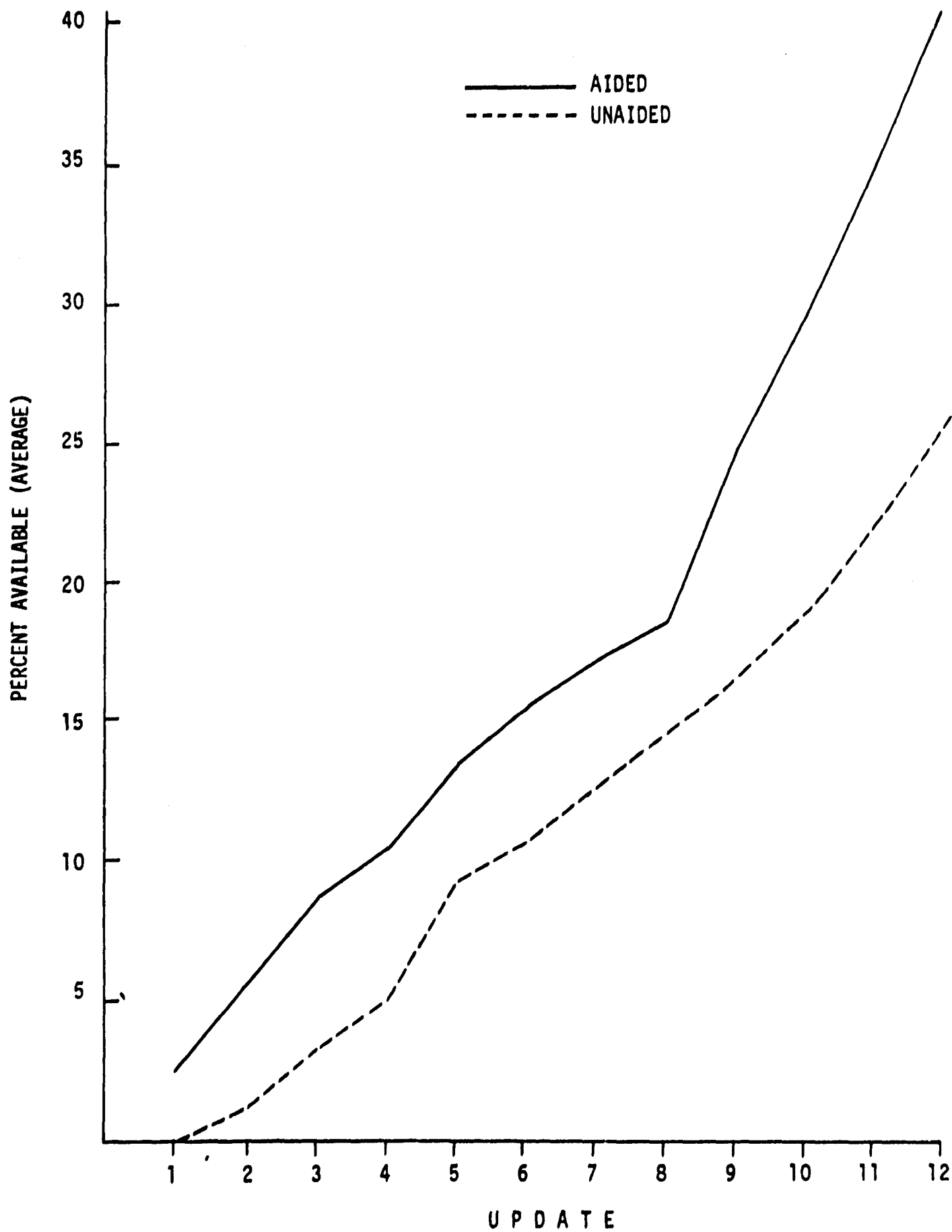
Figure B-79. Weapon Expenditure - 155 MM: Aided/Unaided
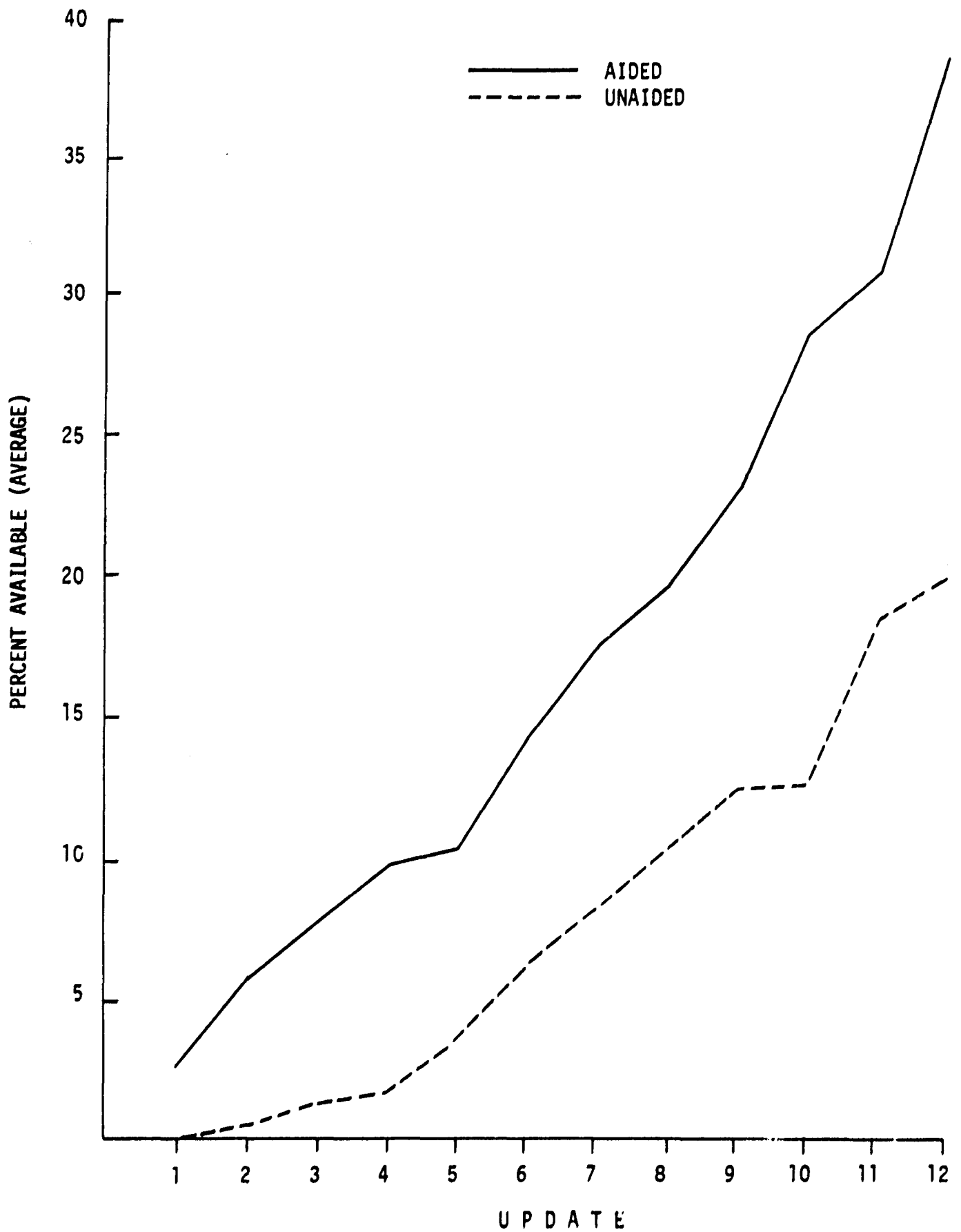
Figure B-80. Weapon Expenditure - 8": Aided/Unaided
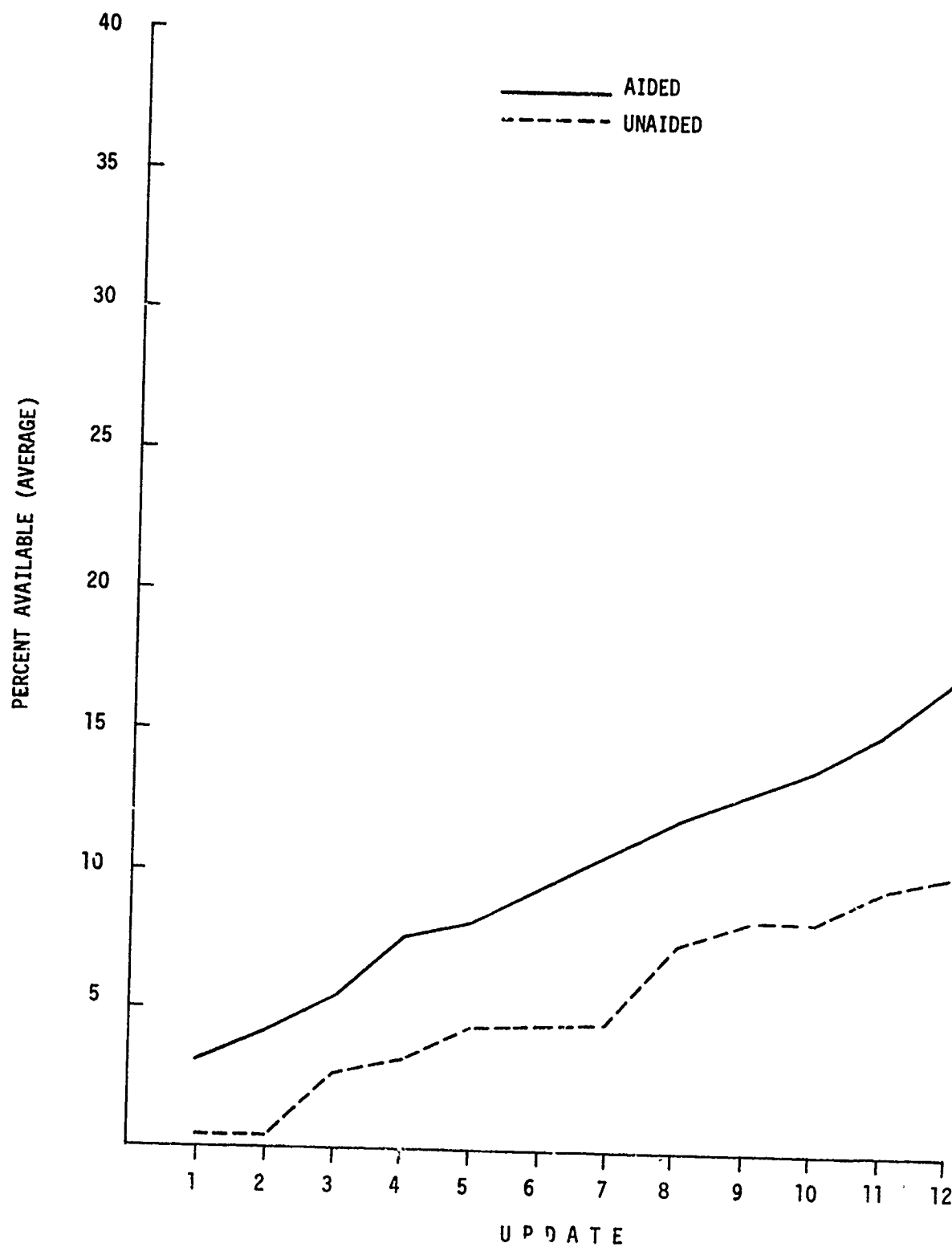
Figure B-81. Weapon Expenditure - HJ: Aided/Unaided
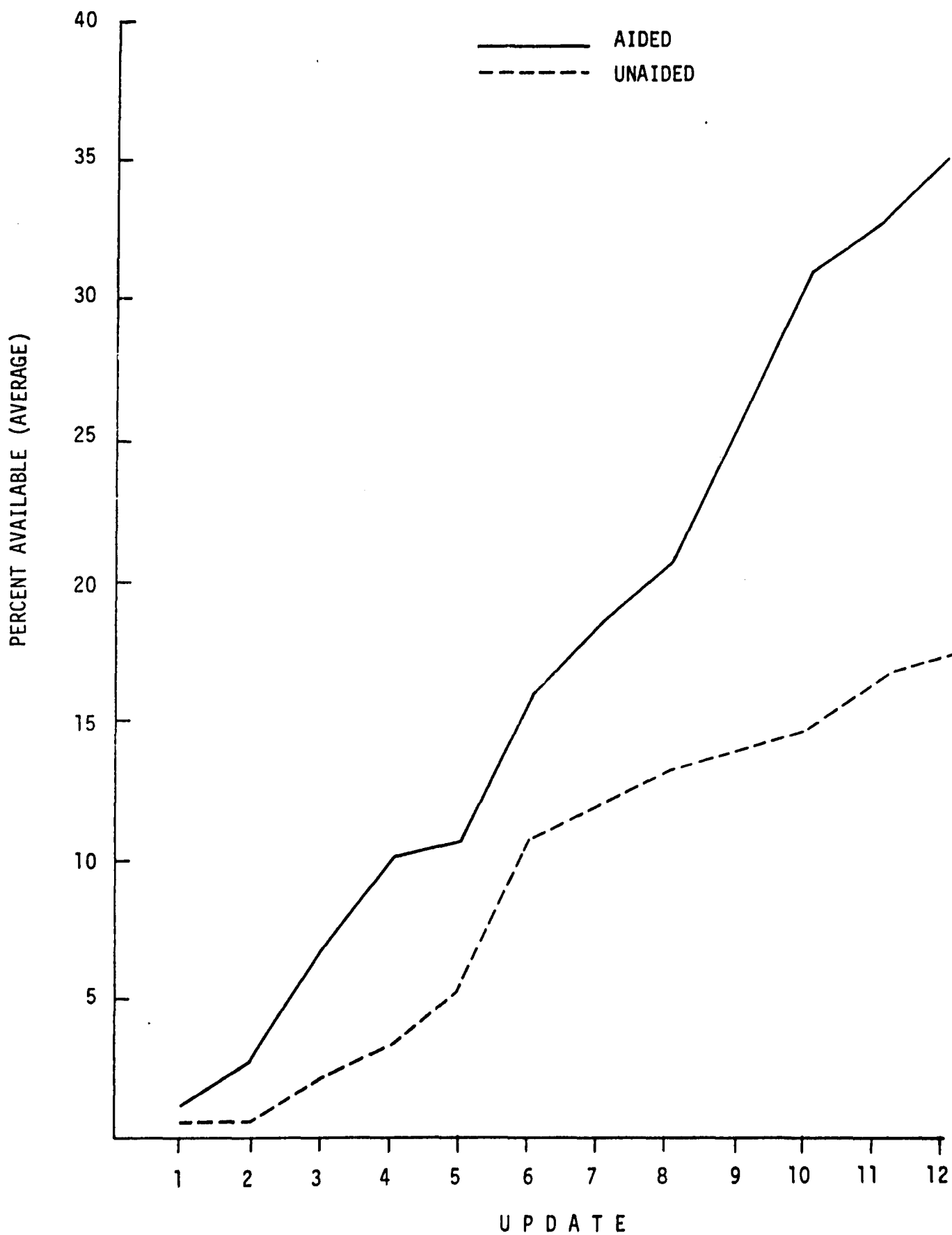
Figure B-82. Weapon Expenditure Tac Air: Aided/Unaided
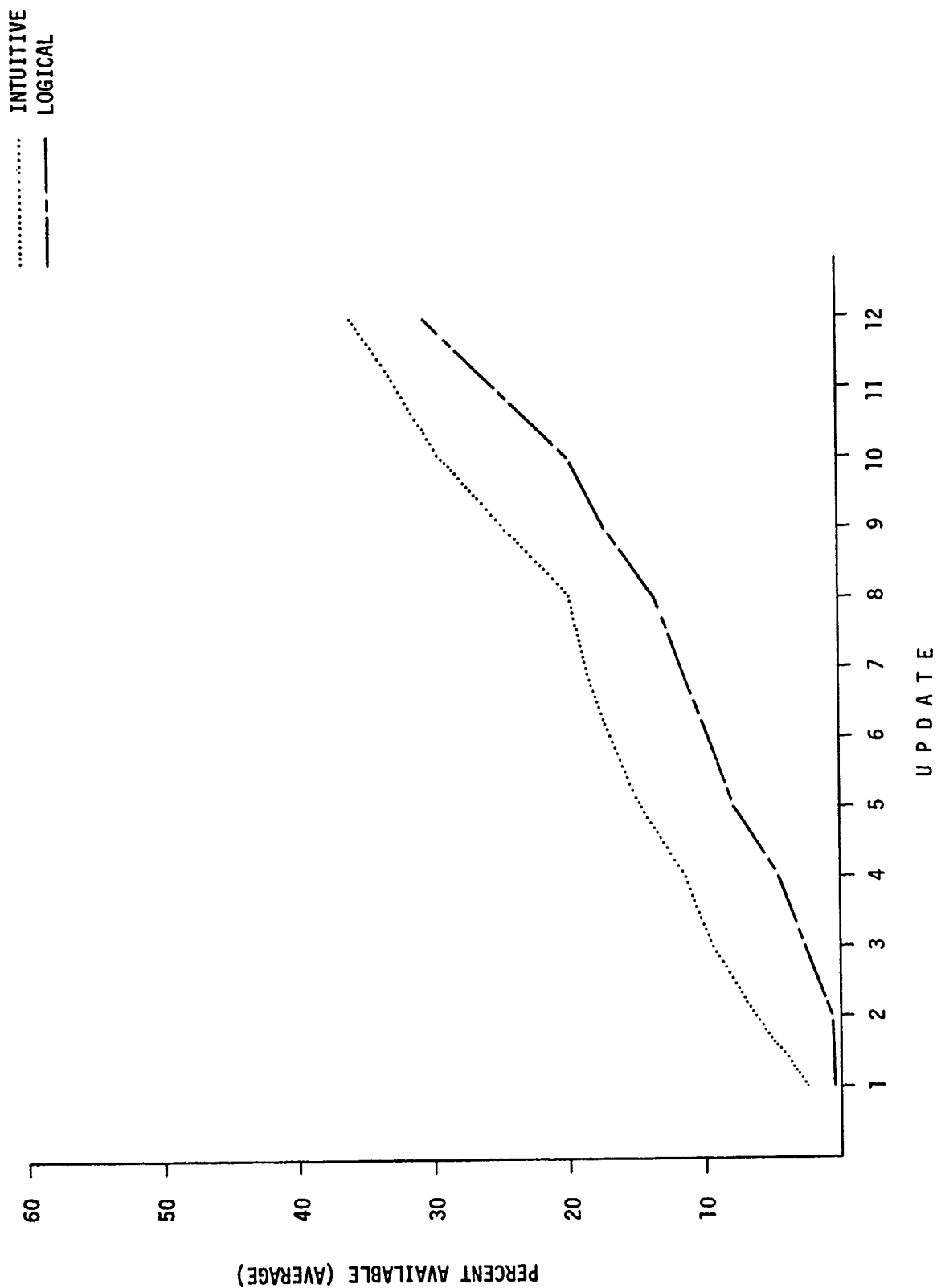
Figure B-83. Weapon Expenditure - 155 MM: Logical/Intuitive
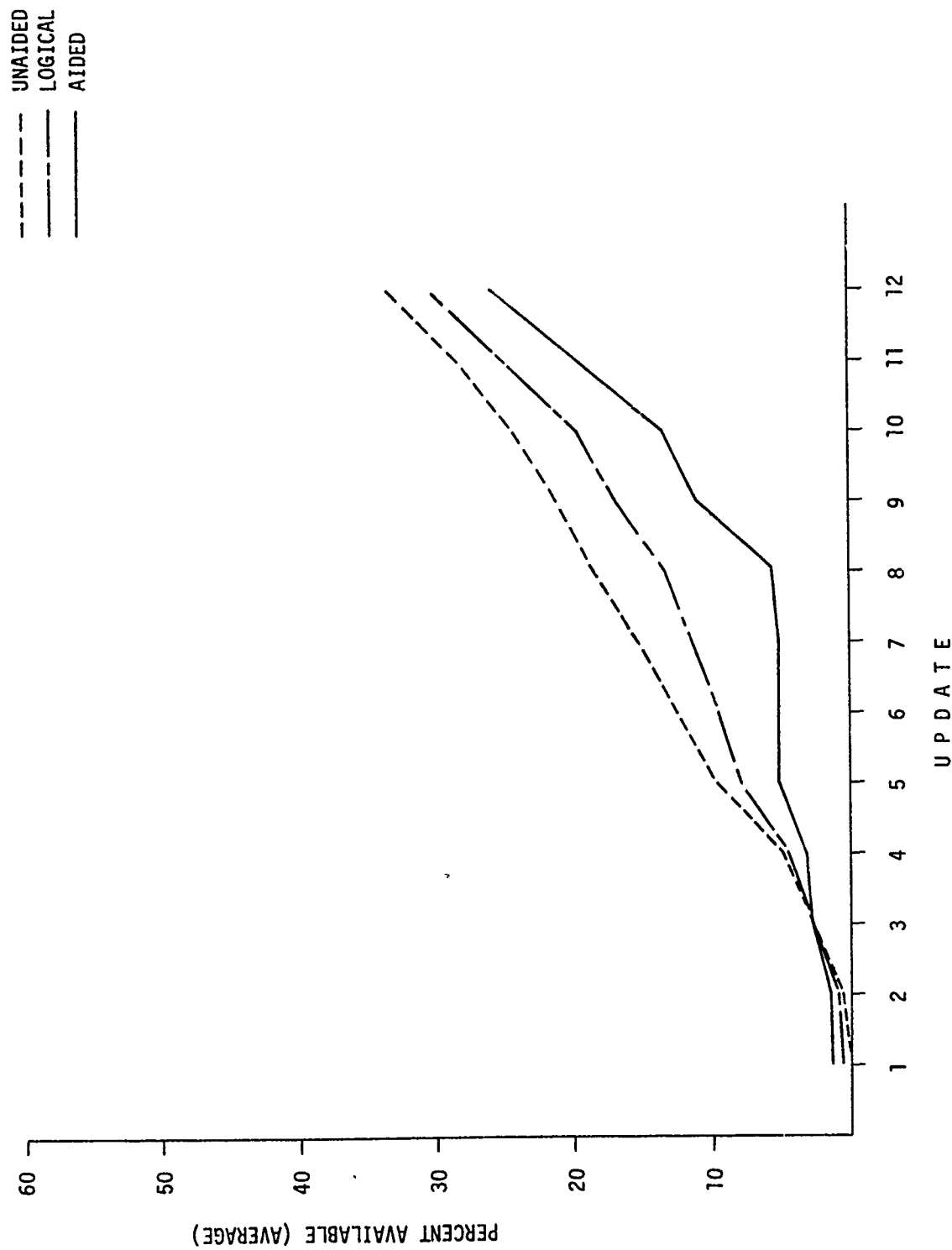
Figure B-84. Weapon Expenditure - 155 MM: Logical (Aided and Unaided)
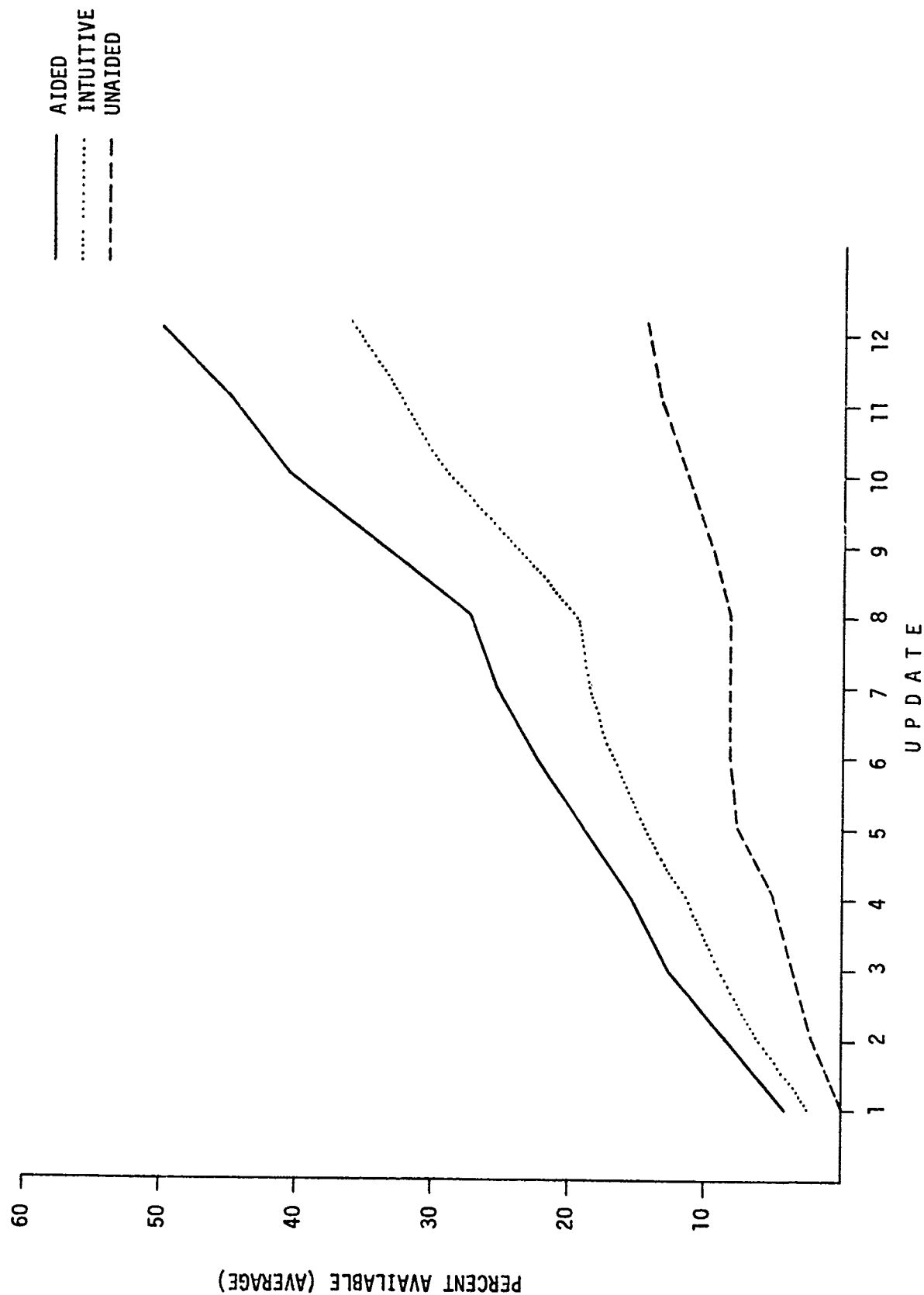
Figure B-85. Weapon Expenditure – 155 MM: Intuitive (Aided and Unaided)
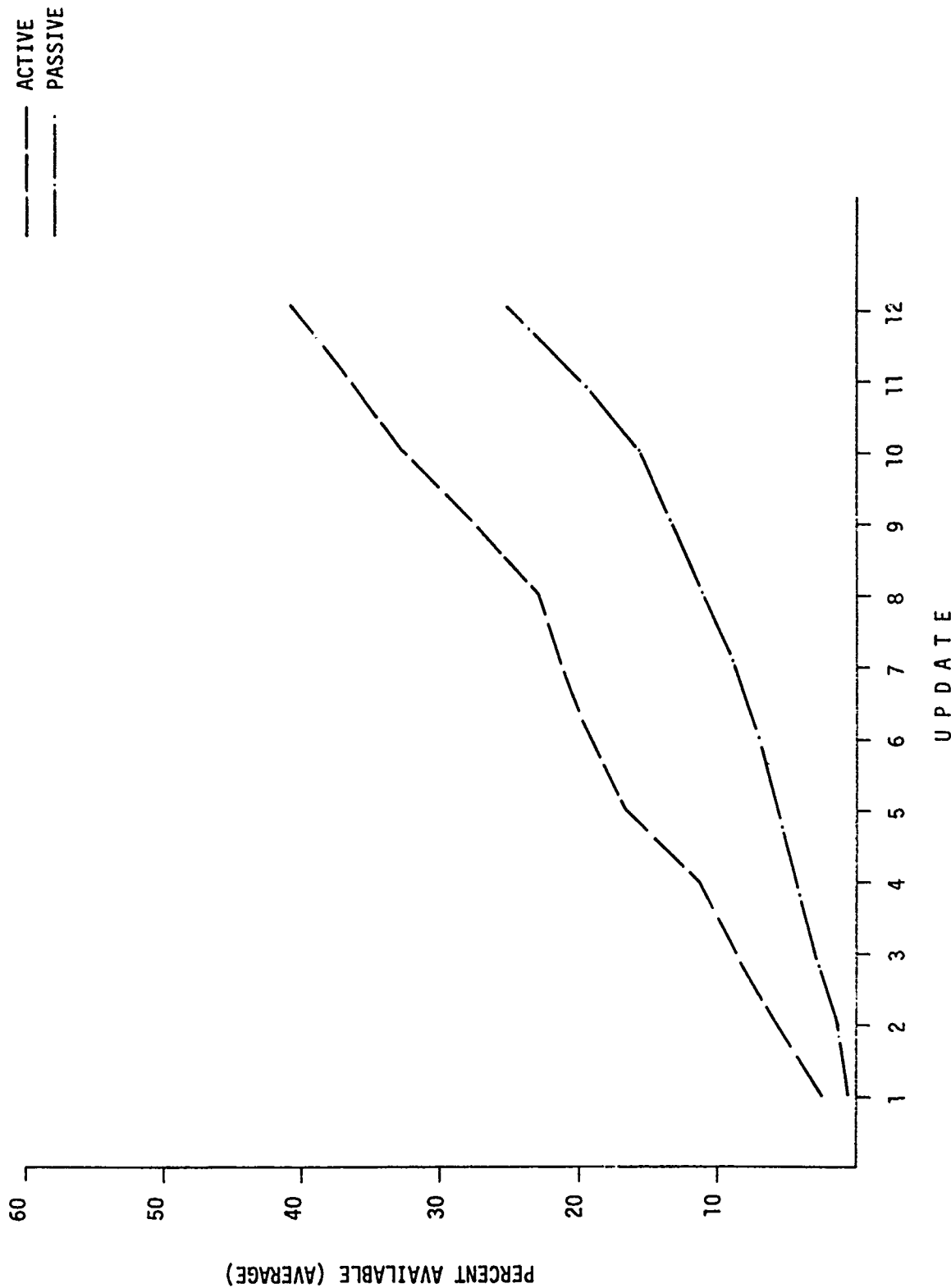
Figure B-86. Weapon Expenditure – 155 MM: Active/Passive
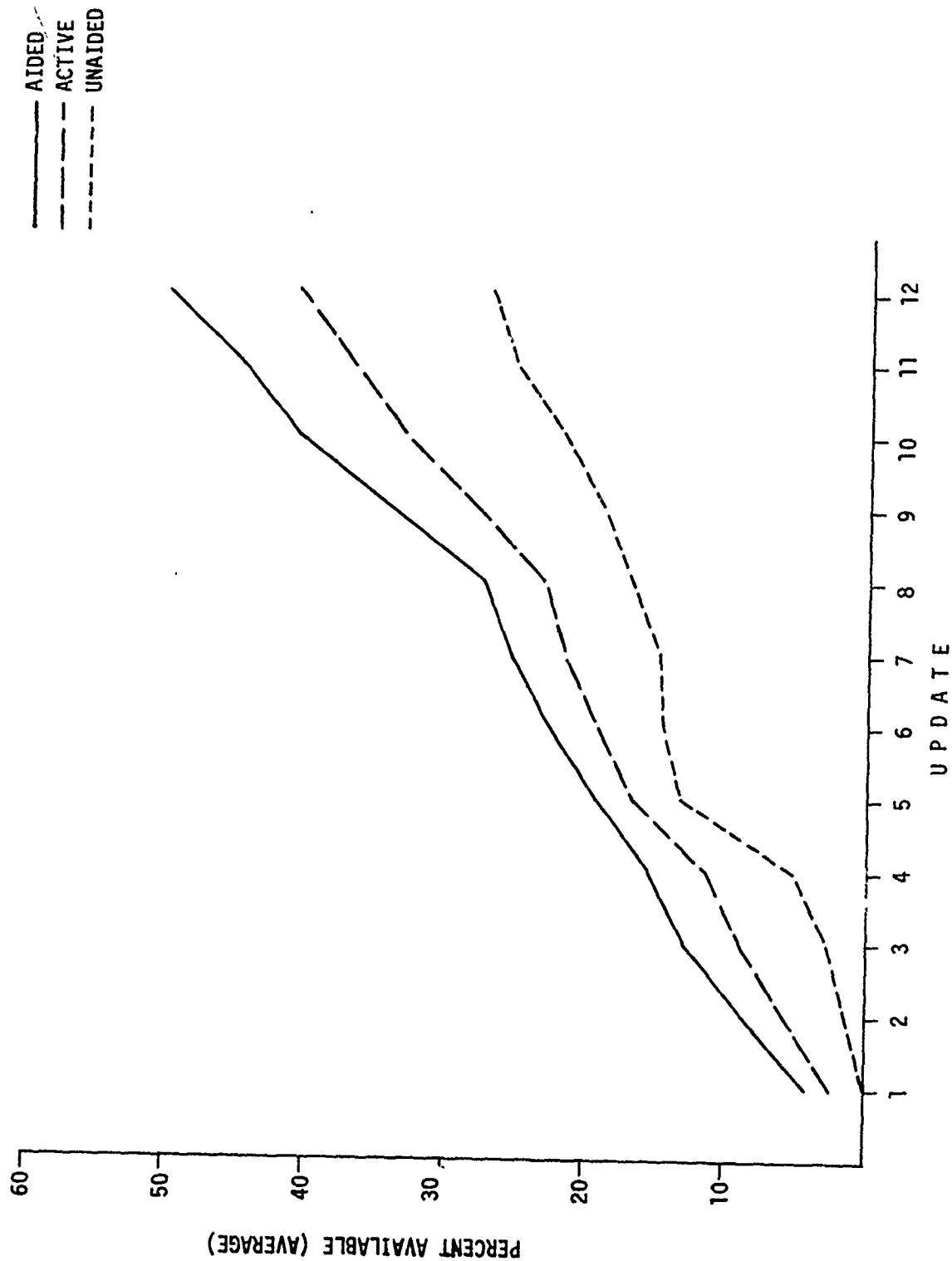
Figure B-87. Weapon Expenditure – 155 MM: Active (Aided and Unaided)

UNAIDED
PASSIVE
AIDED

PERCENT AVAILABLE (AVERAGE)

60
50
40
30
20
10

UPDATE

1 2 3 4 5 6 7 8 9 10 11 12
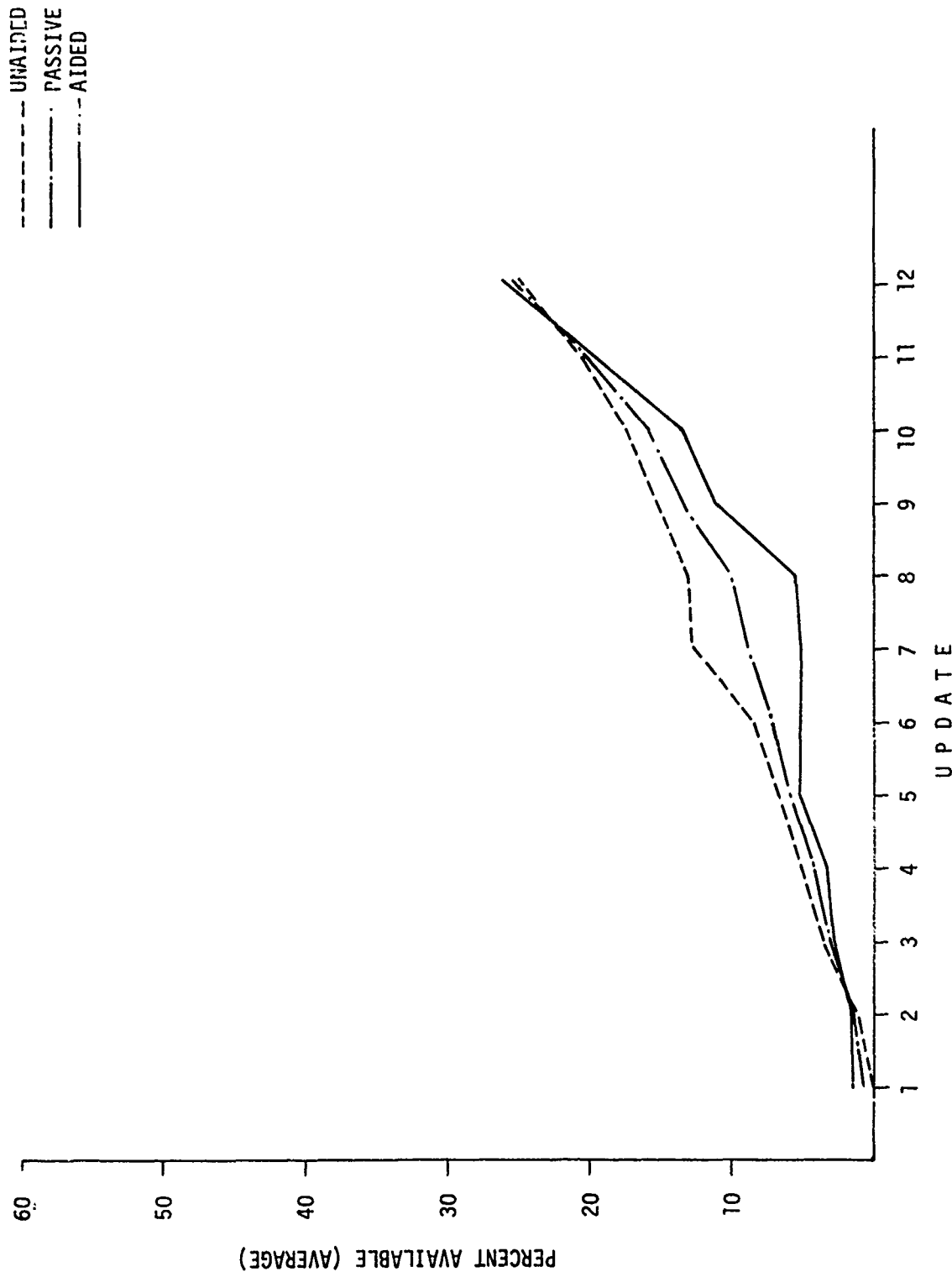
Figure B-88. Weapon Expenditure - 155 MM: Passive (Aided and Unaided)

PERCENT AVAILABLE (AVERAGE)

UPDATE

LOW ABSTRACT
HIGH ABSTRACT
CONCRETE
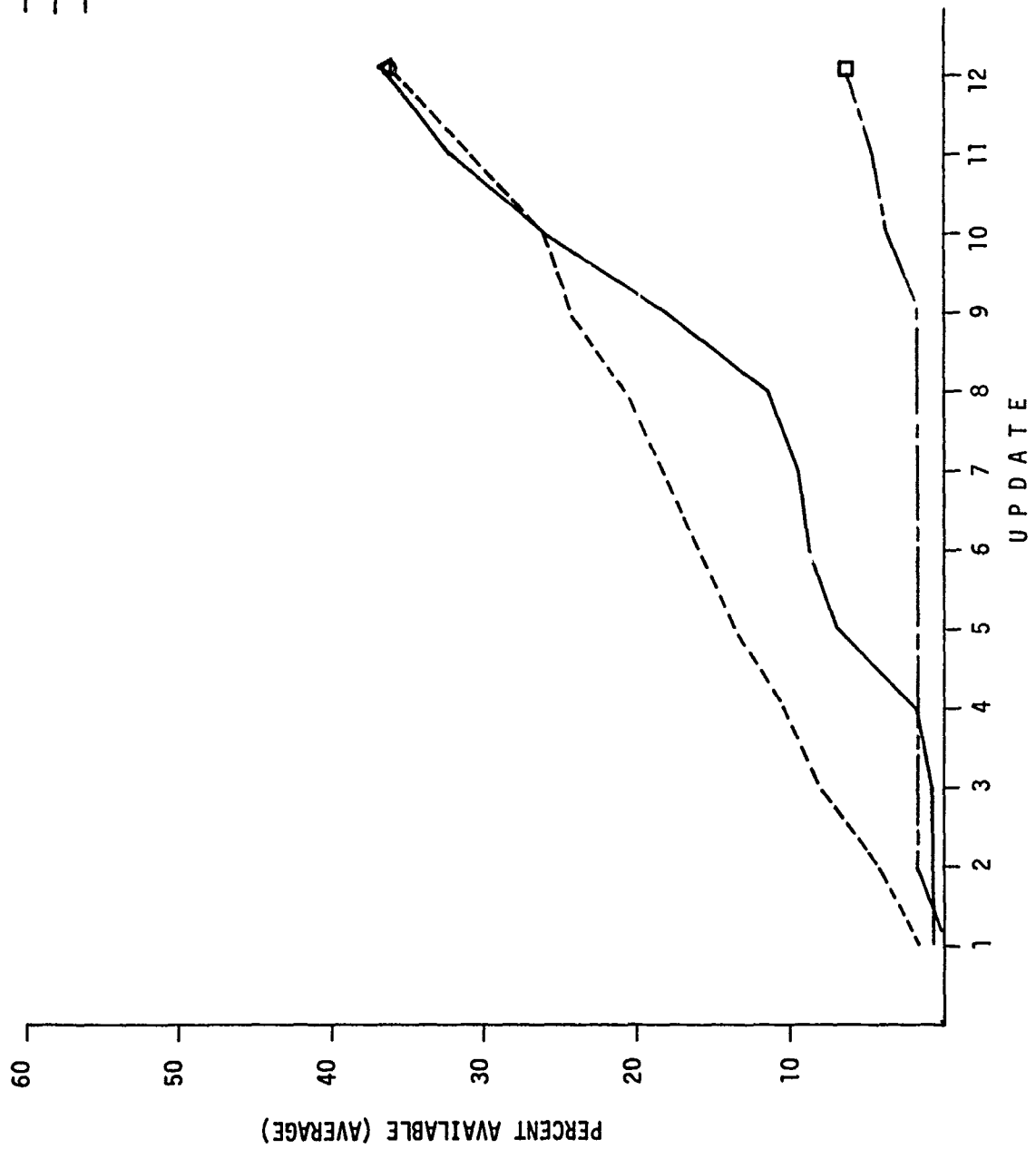
Figure B-89. Weapon Expenditure – 155 MM: High Abstract/Low Abstract/Concrete.

PERCENT AVAILABLE (AVERAGE)

60

50

40

30

20

10

1 2 3 4 5 6 7 8 9 10 11 12

U P D A T E

AIDED

LOW ABSTRACT
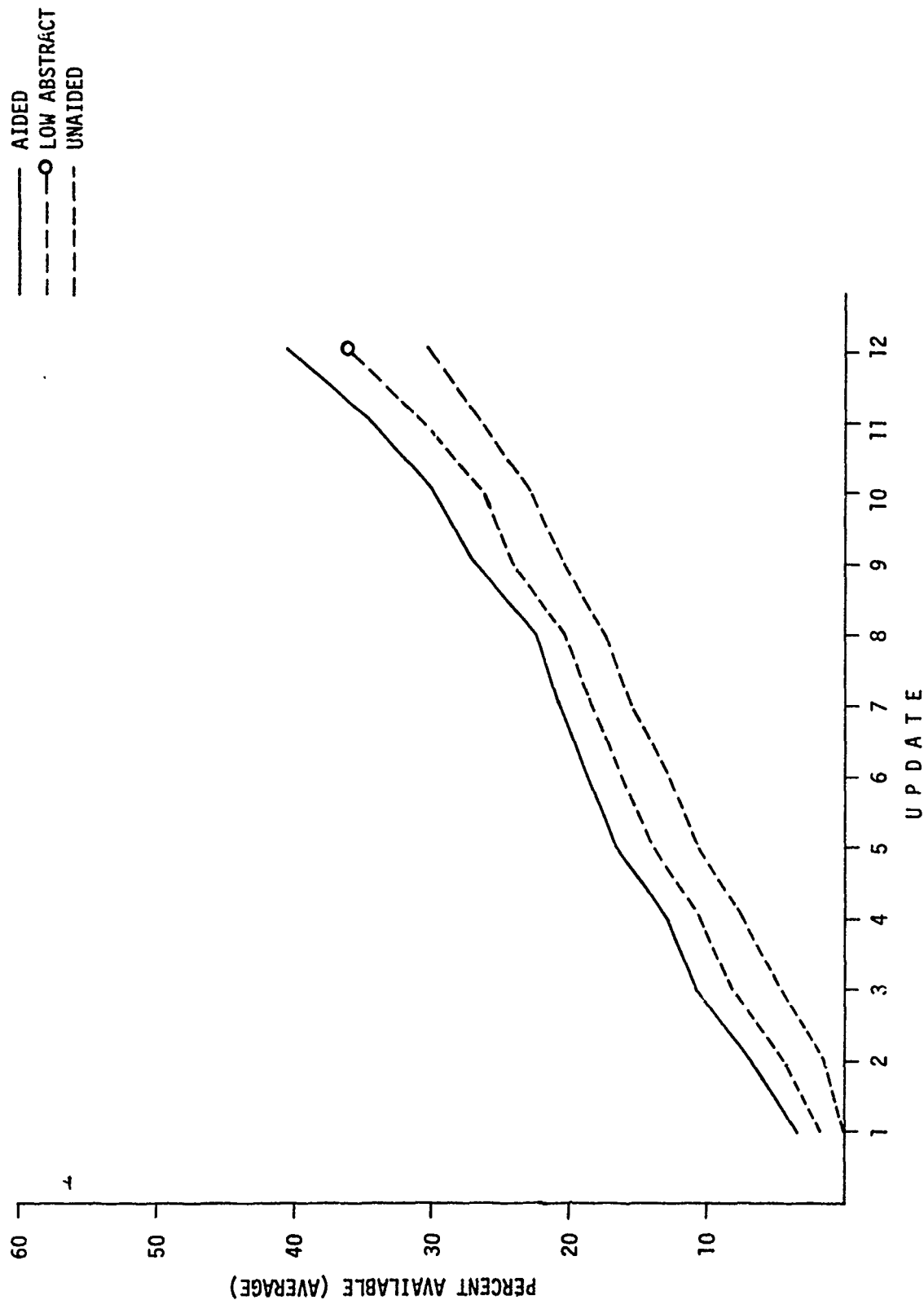
UNAIDED

Figure B-90. Weapon Expenditure – 155 MM: Low Abstract (Aided and Unaided)
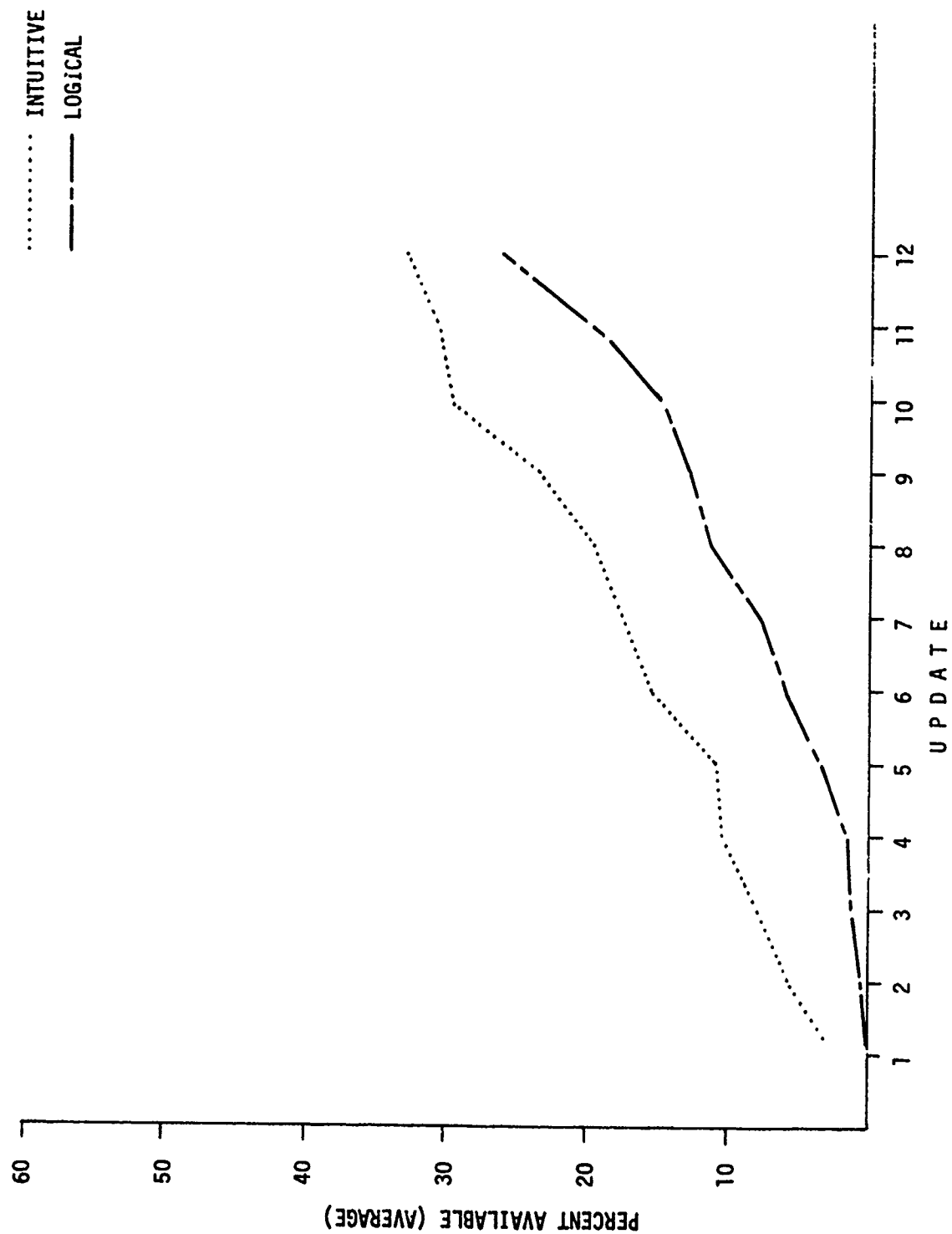
Figure B-91. Weapon Expenditure — {"}: Logical/Intuitive

INTUITIVE

LOGICAL

PERCENT AVAILABLE (AVERAGE)

UPDATE
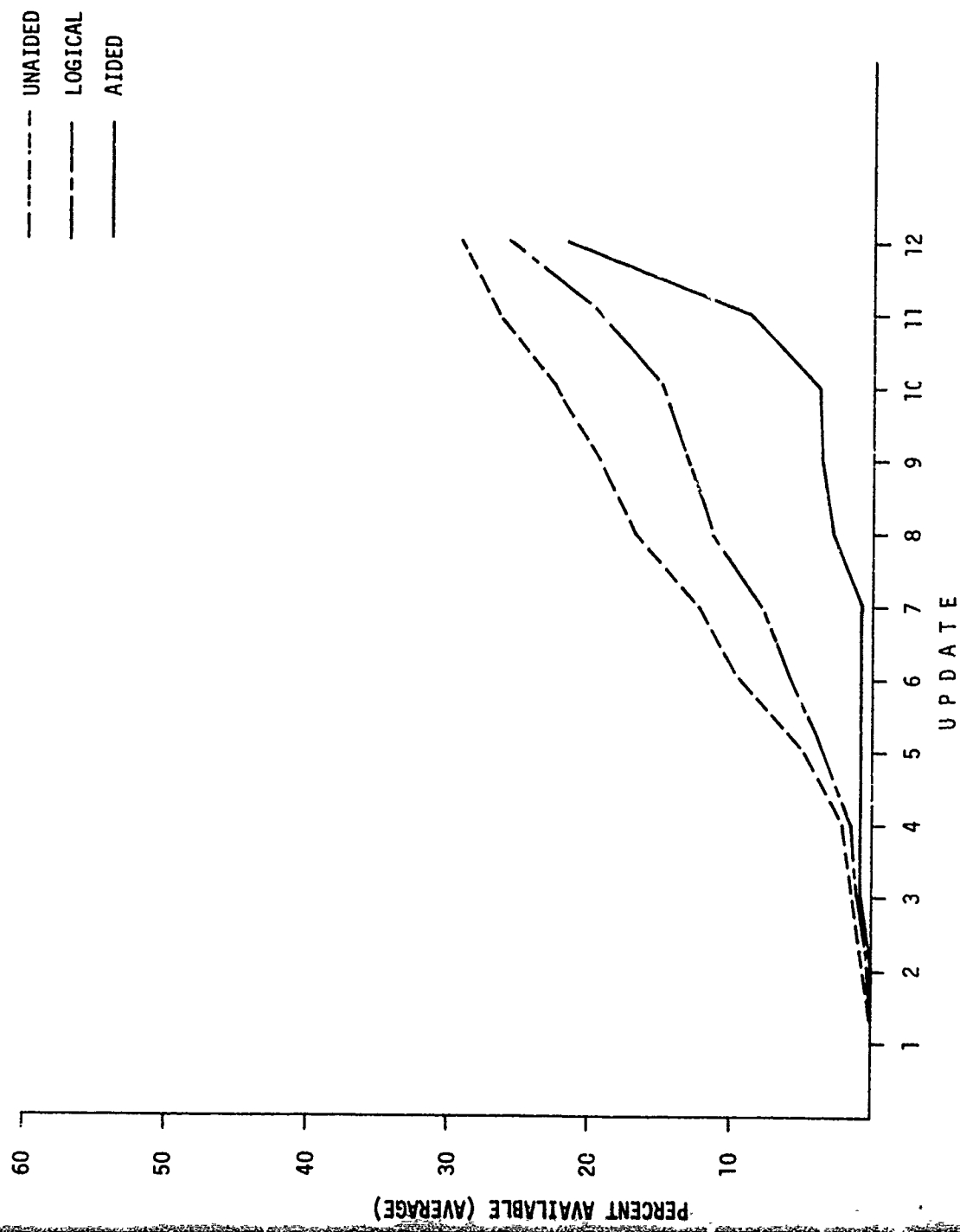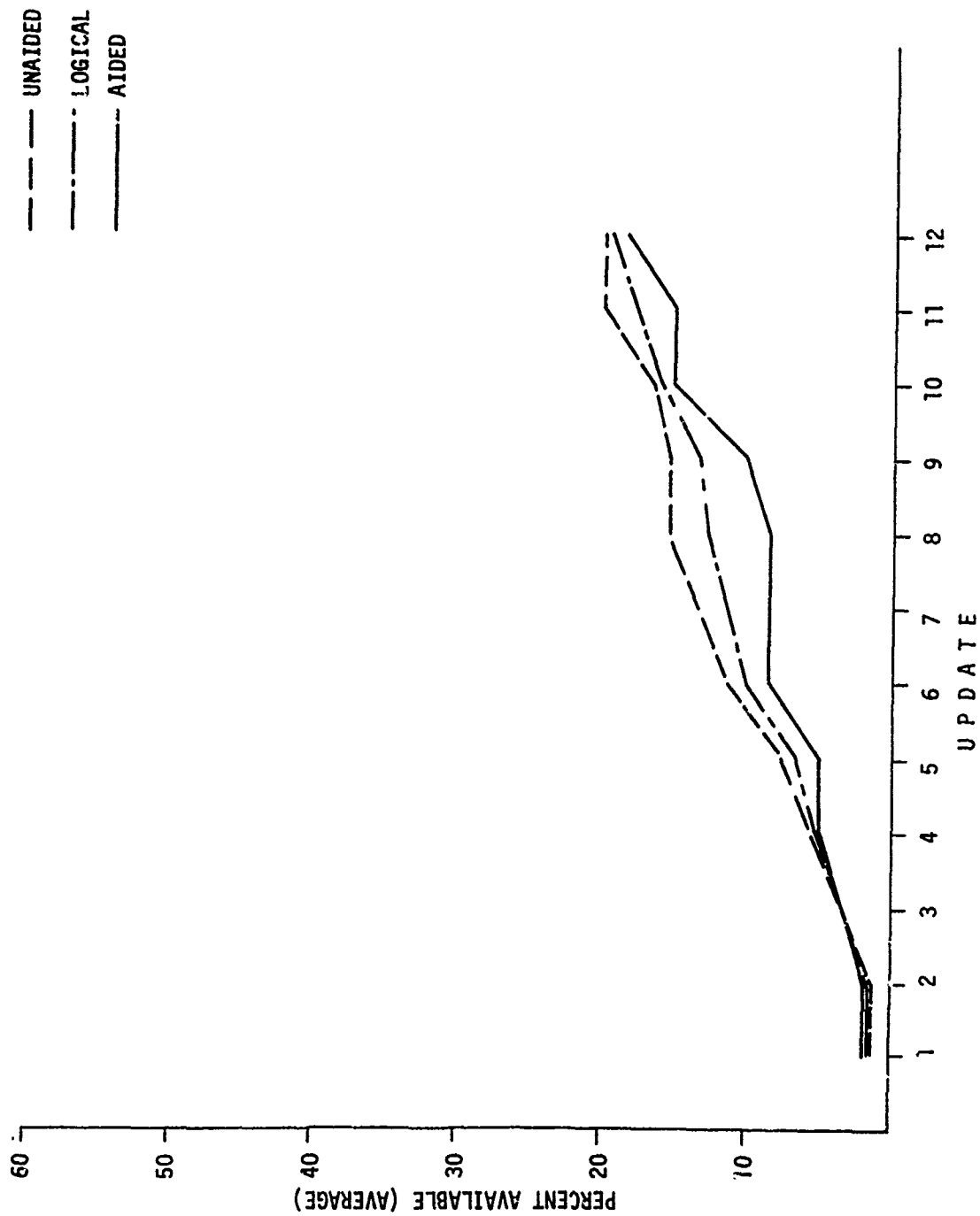
Figure B-92. Weapon Expenditure – 8": Logical (Aided and Unaided)
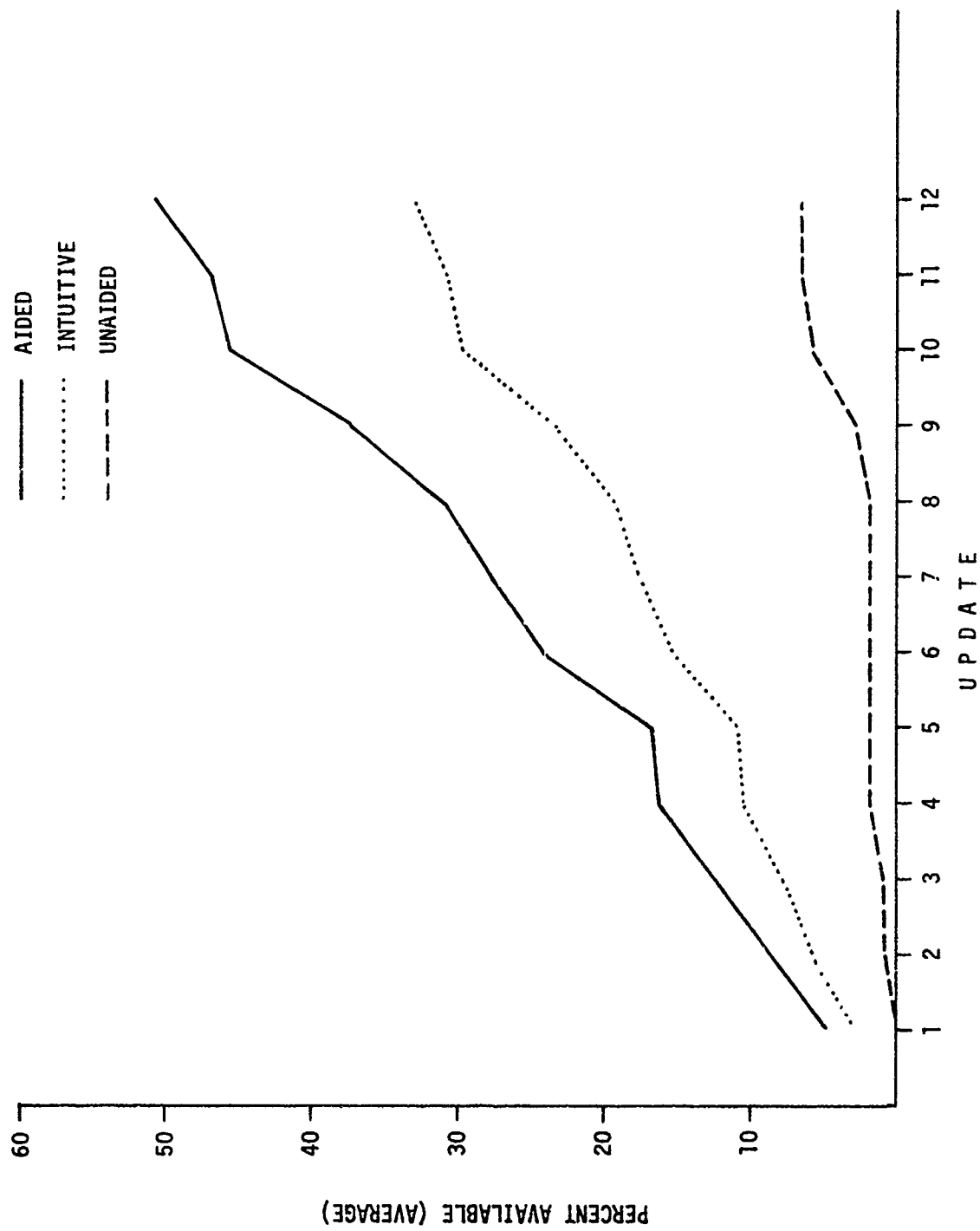
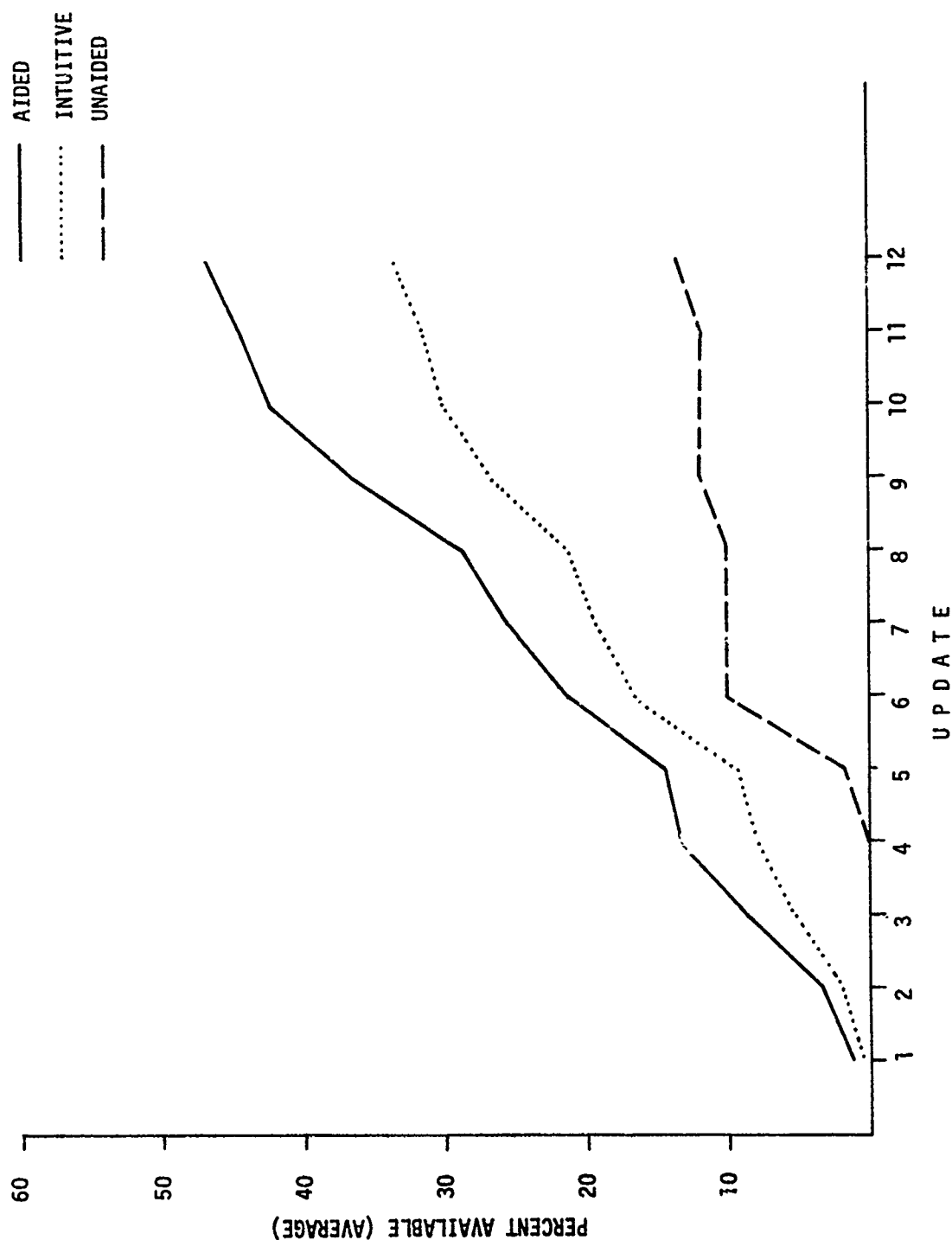Figure B-93. Weapon Expenditure - 8": Intuitive (Aided and Unaided)
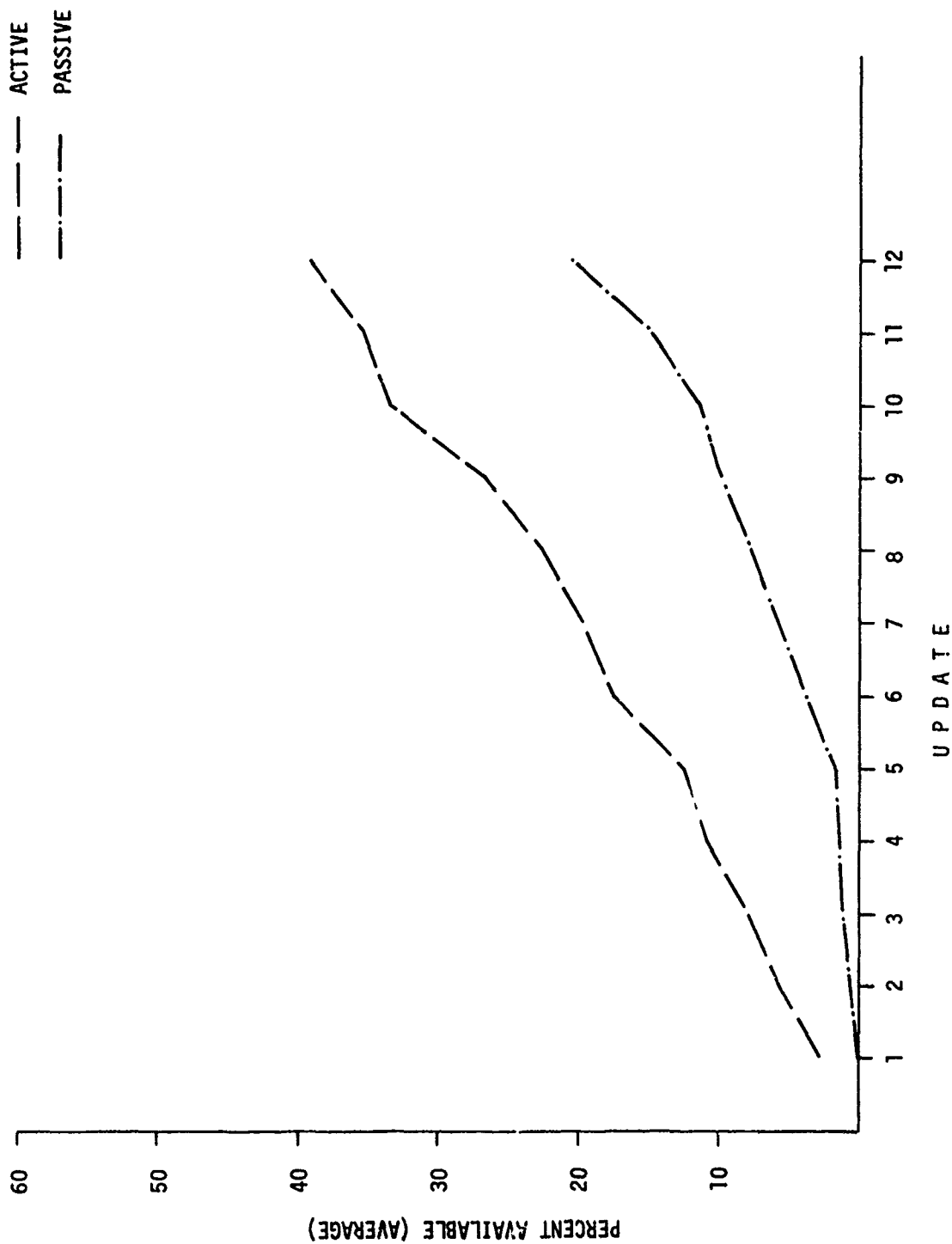
Figure B-94. Weapon Expenditure – 8": Active/Passive
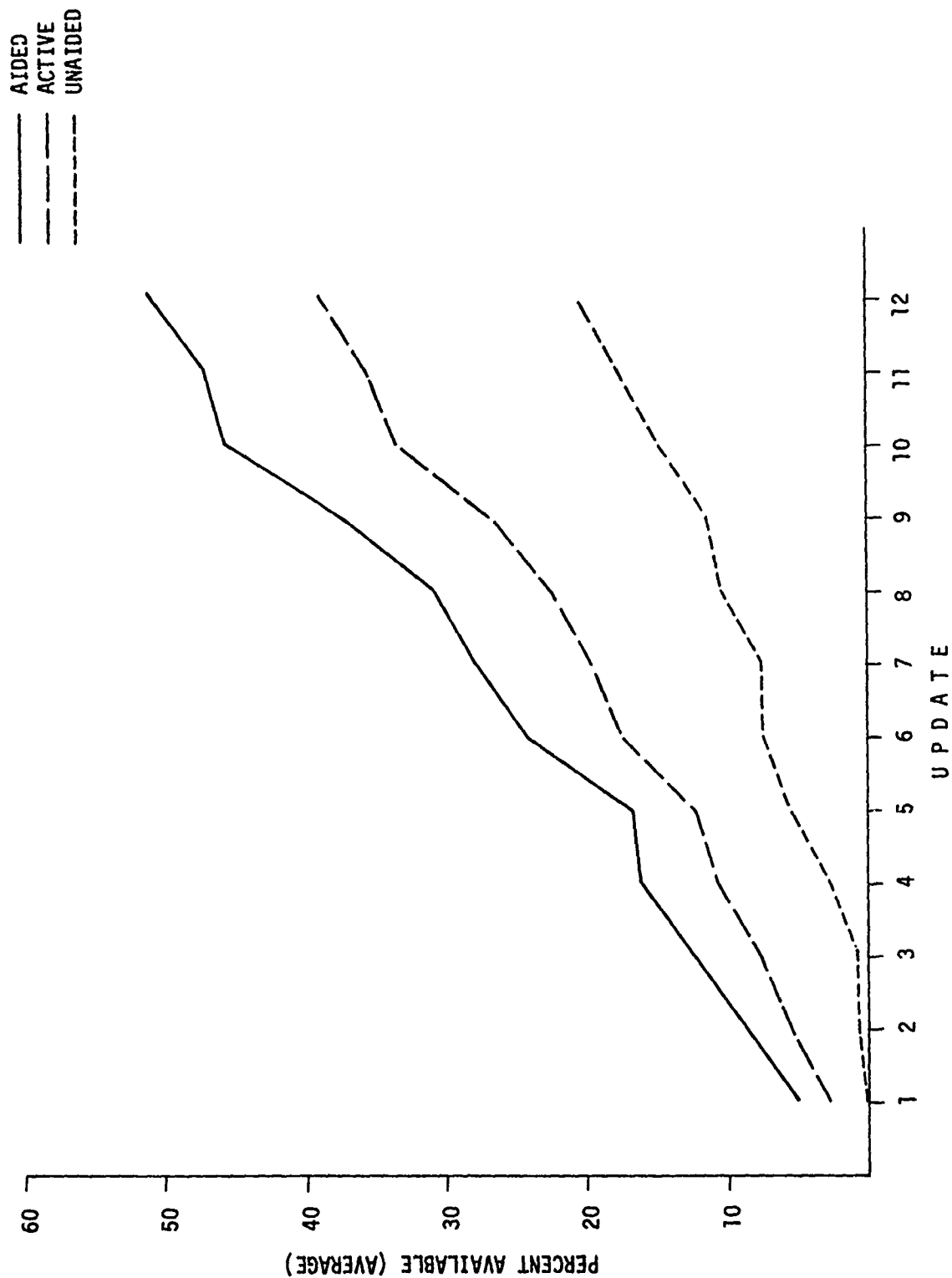
Figure B-95. Weapon Expenditure - 8": Active (Aided and Unaided)
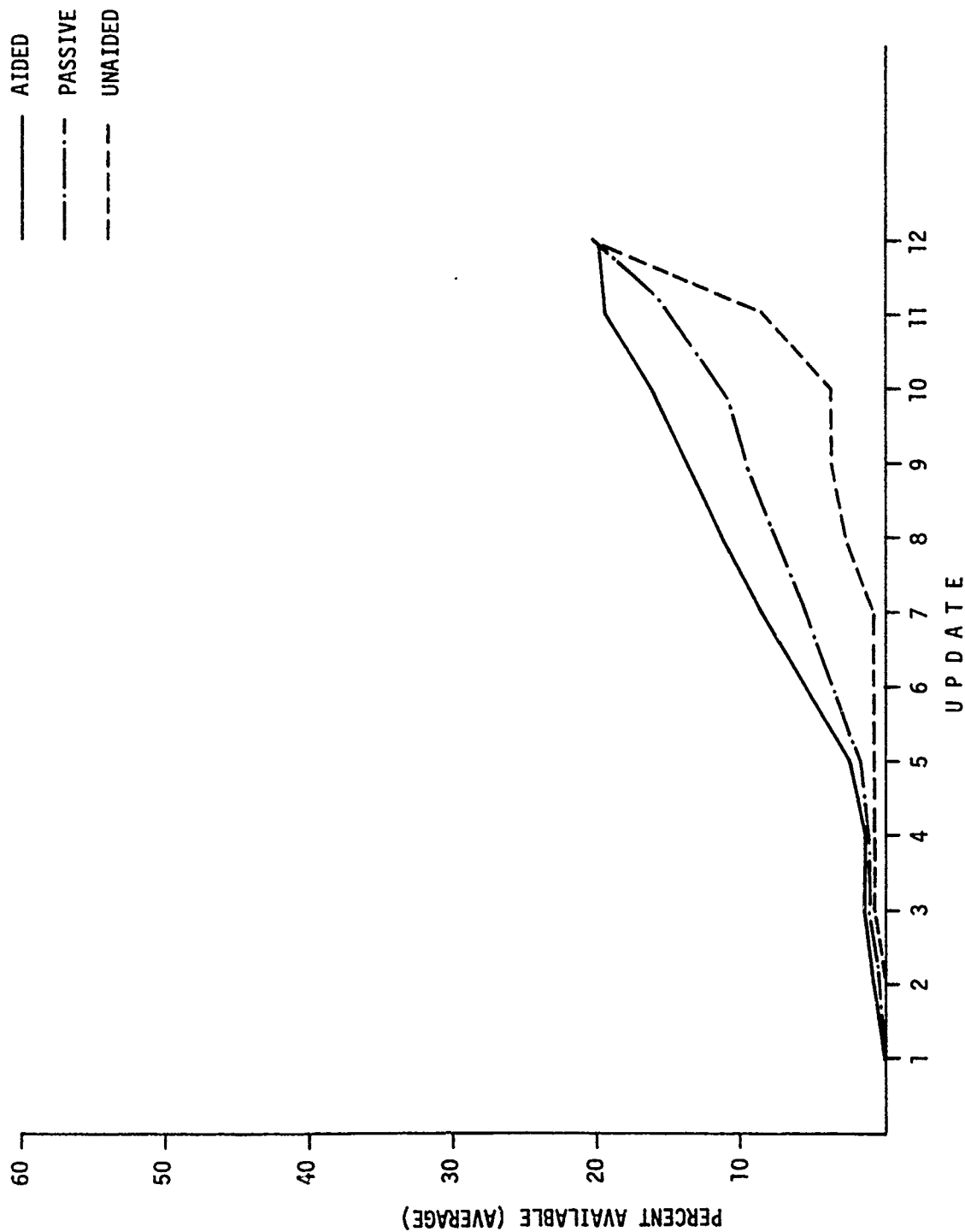
Figure B-96. Weapon Expenditure – 8": Passive (Aided and Unaided)
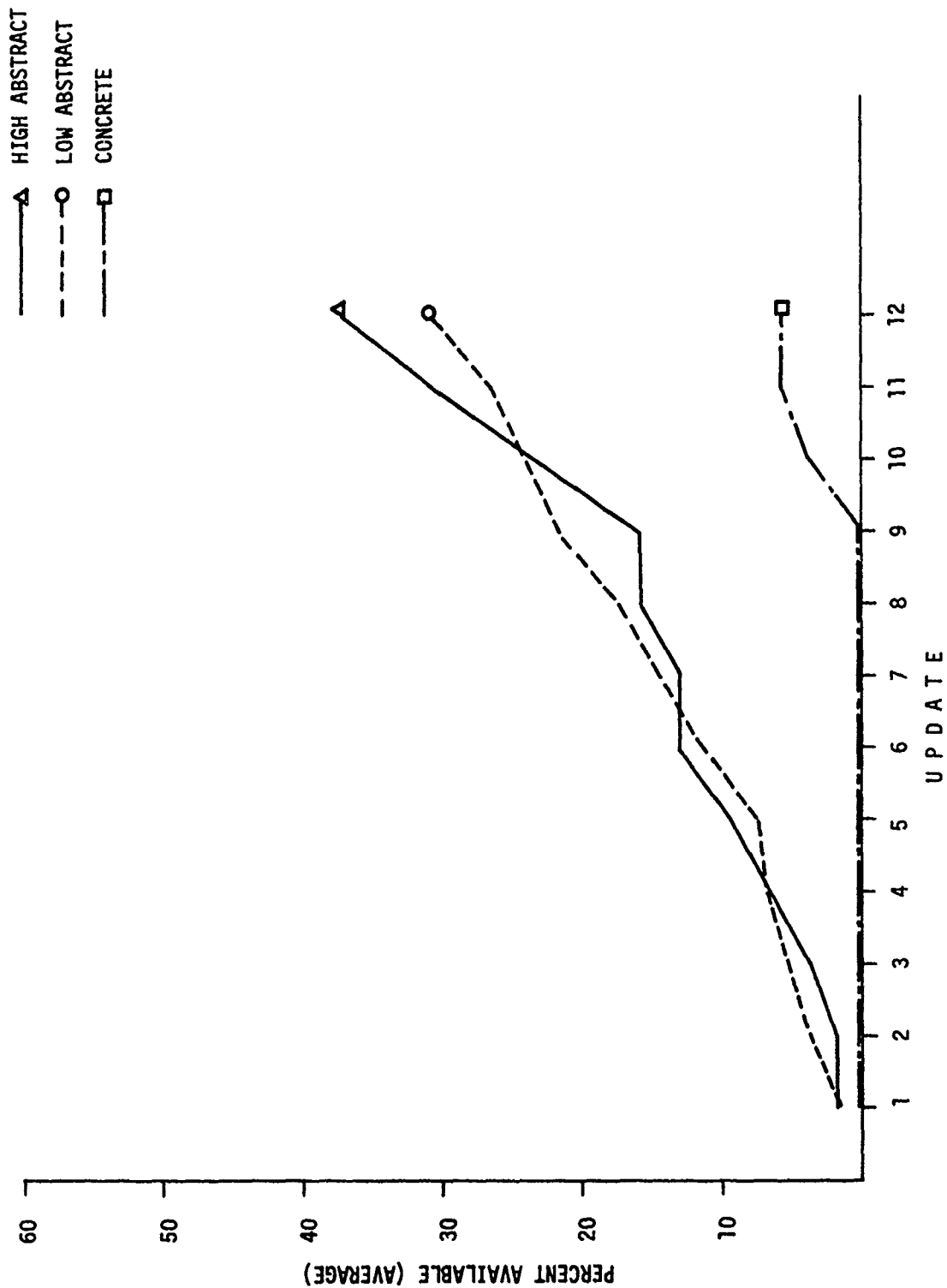
Figure B-97. Weapon Expenditure – 8": High Abstract/Low Abstract/Concrete
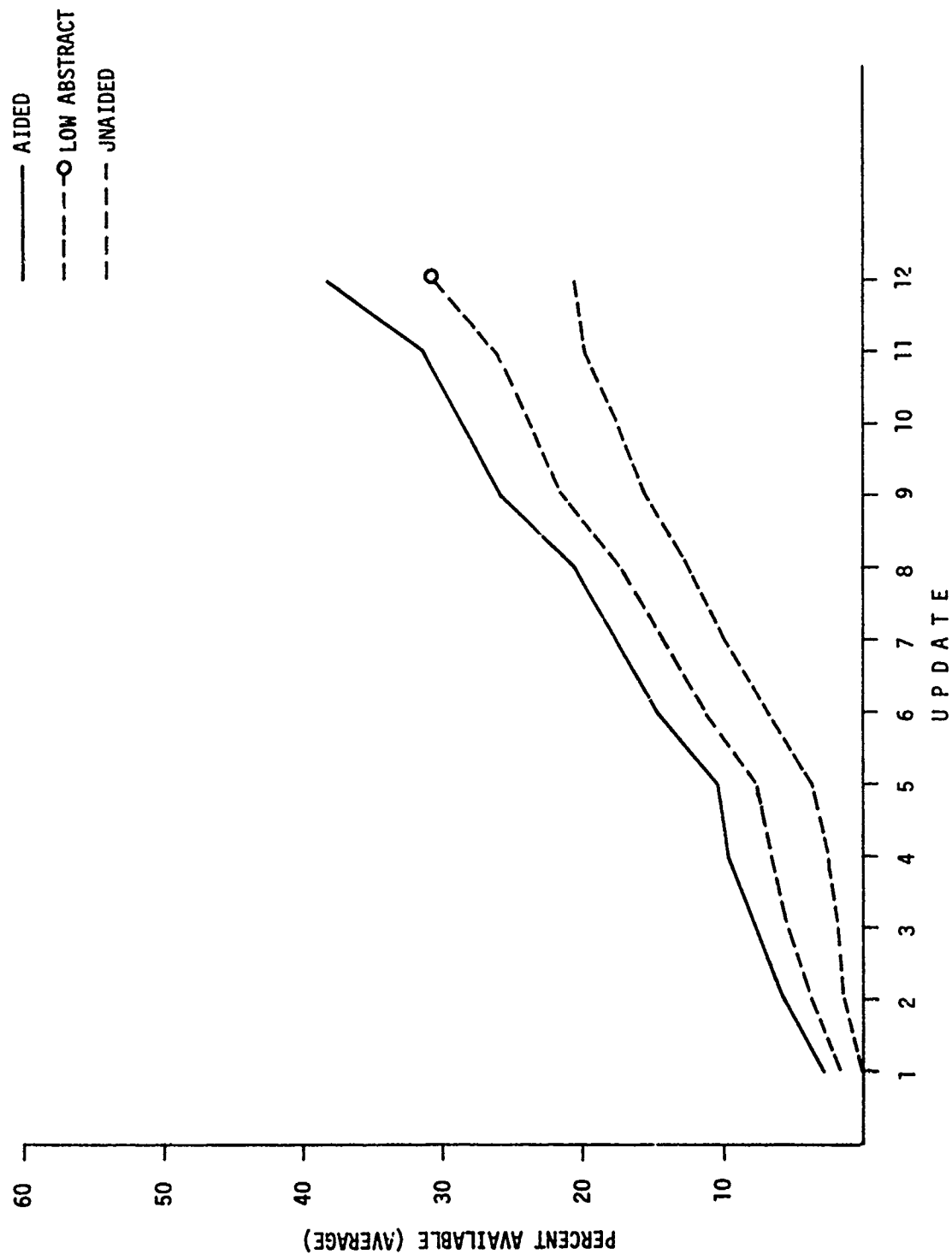
Figure B-98. Weapon Expenditure – 8": Low Abstract (Aided and Unaided)
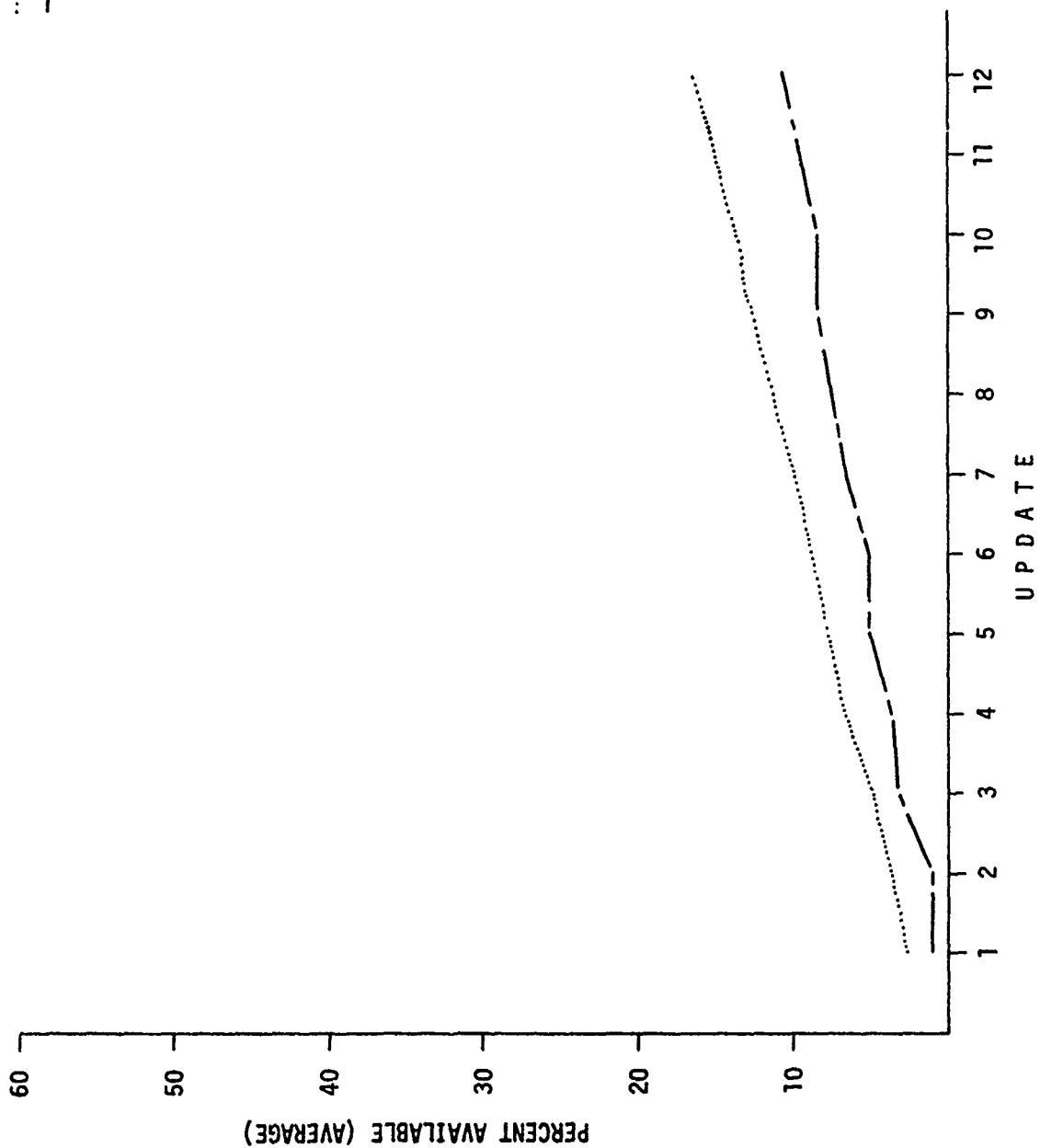
Figure B-99. Weapon Expenditure - HJ: Logical/Intuitive
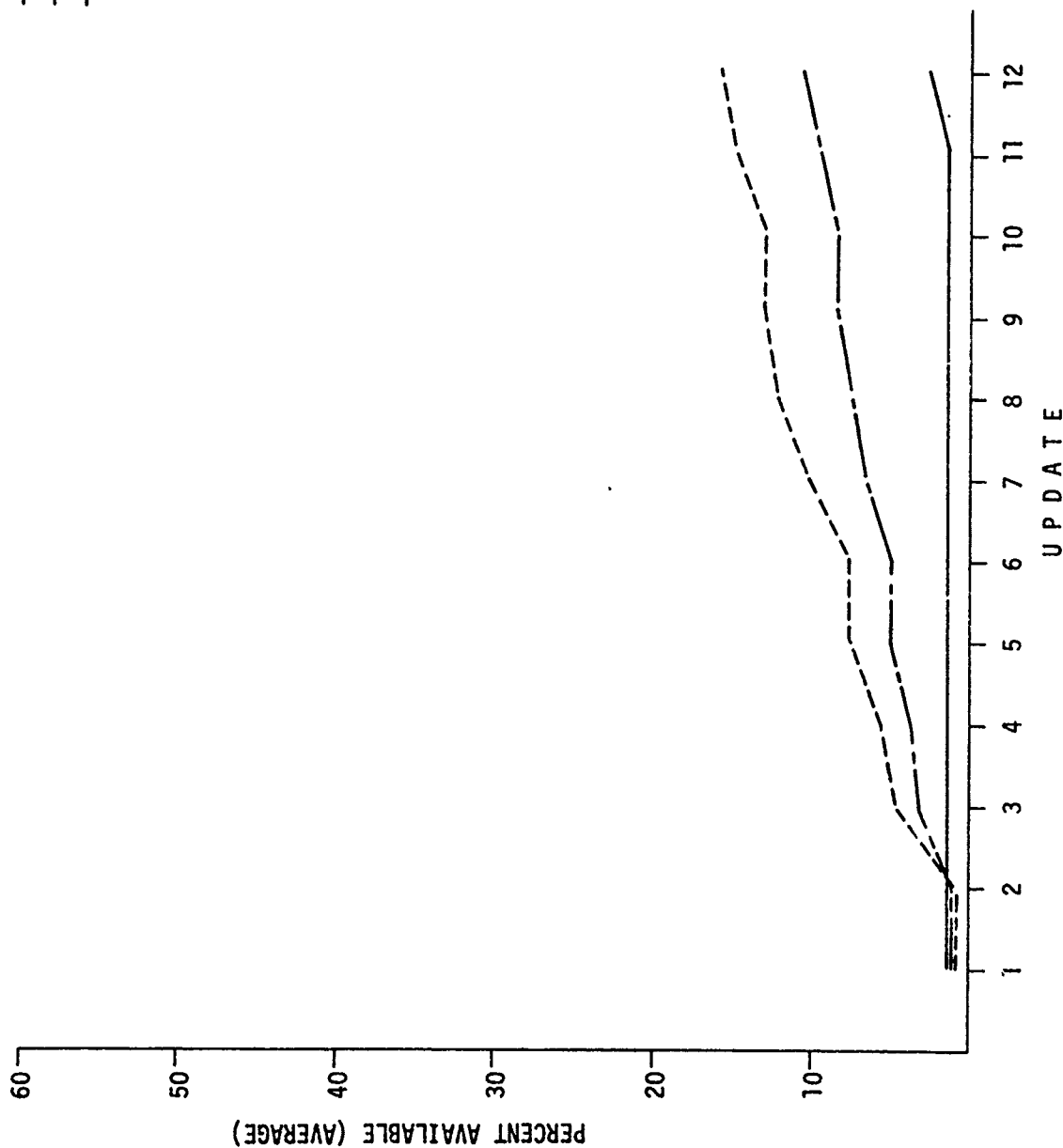
Figure B-100. Weapon Expenditure – HJ: Logical (Aided and Unaided)

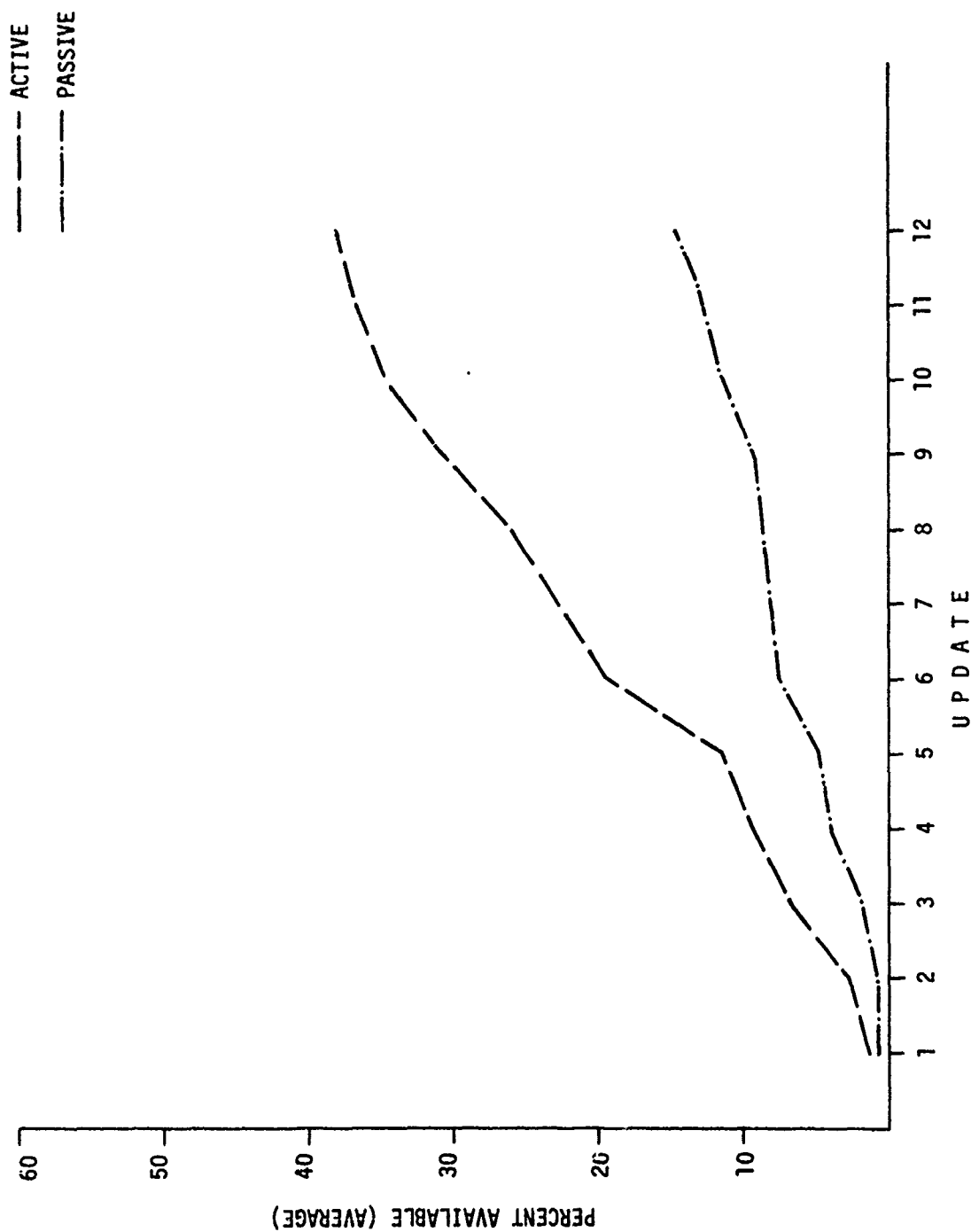Figure B-101. Weapon Expenditure - HJ: Intuitive (Aided and Unaided)

ACTIVE
PASSIVE

PERCENT AVAILABLE (AVERAGE)

60 50 40 30 20 10

1 2 3 4 5 6 7 8 9 10 11 12

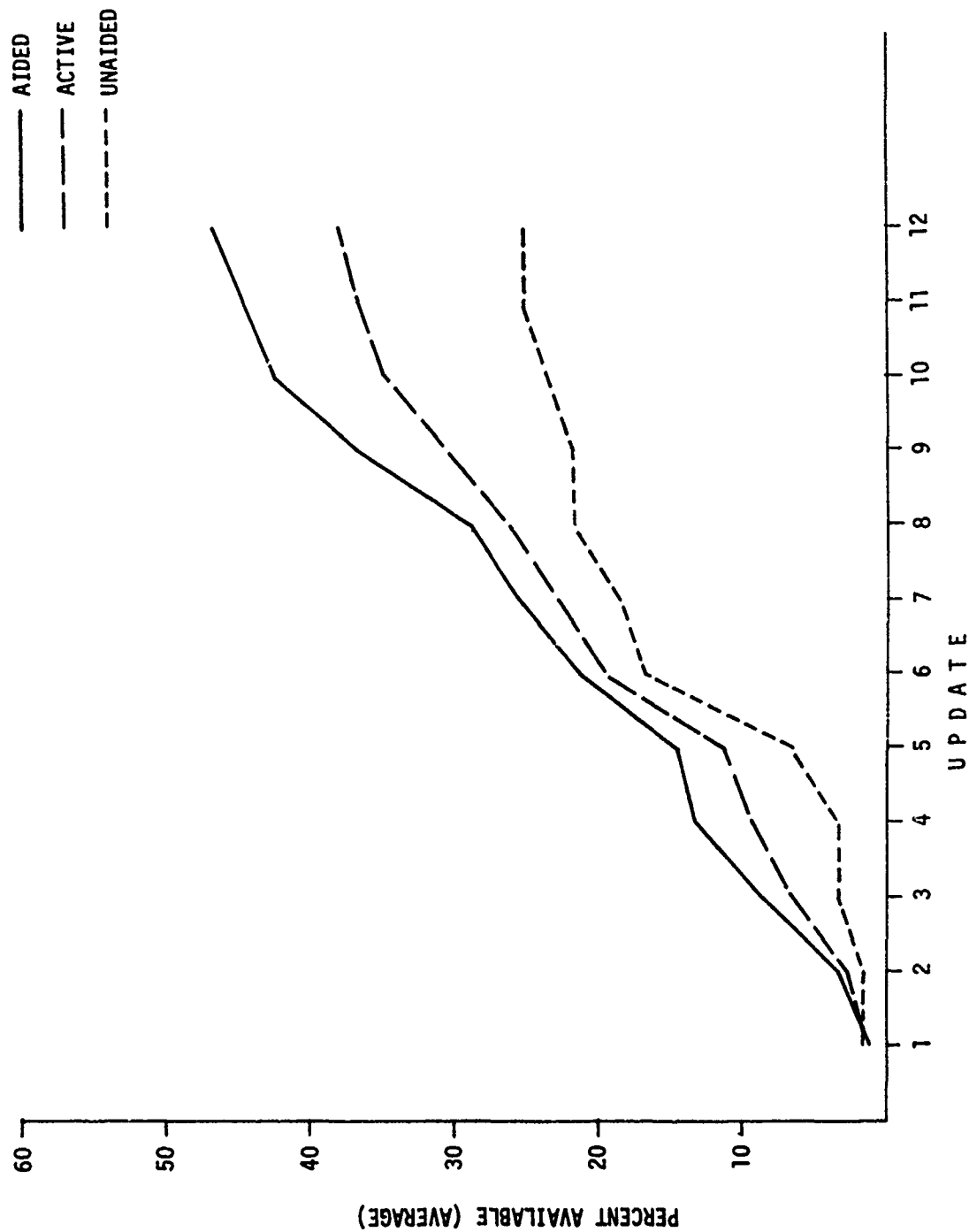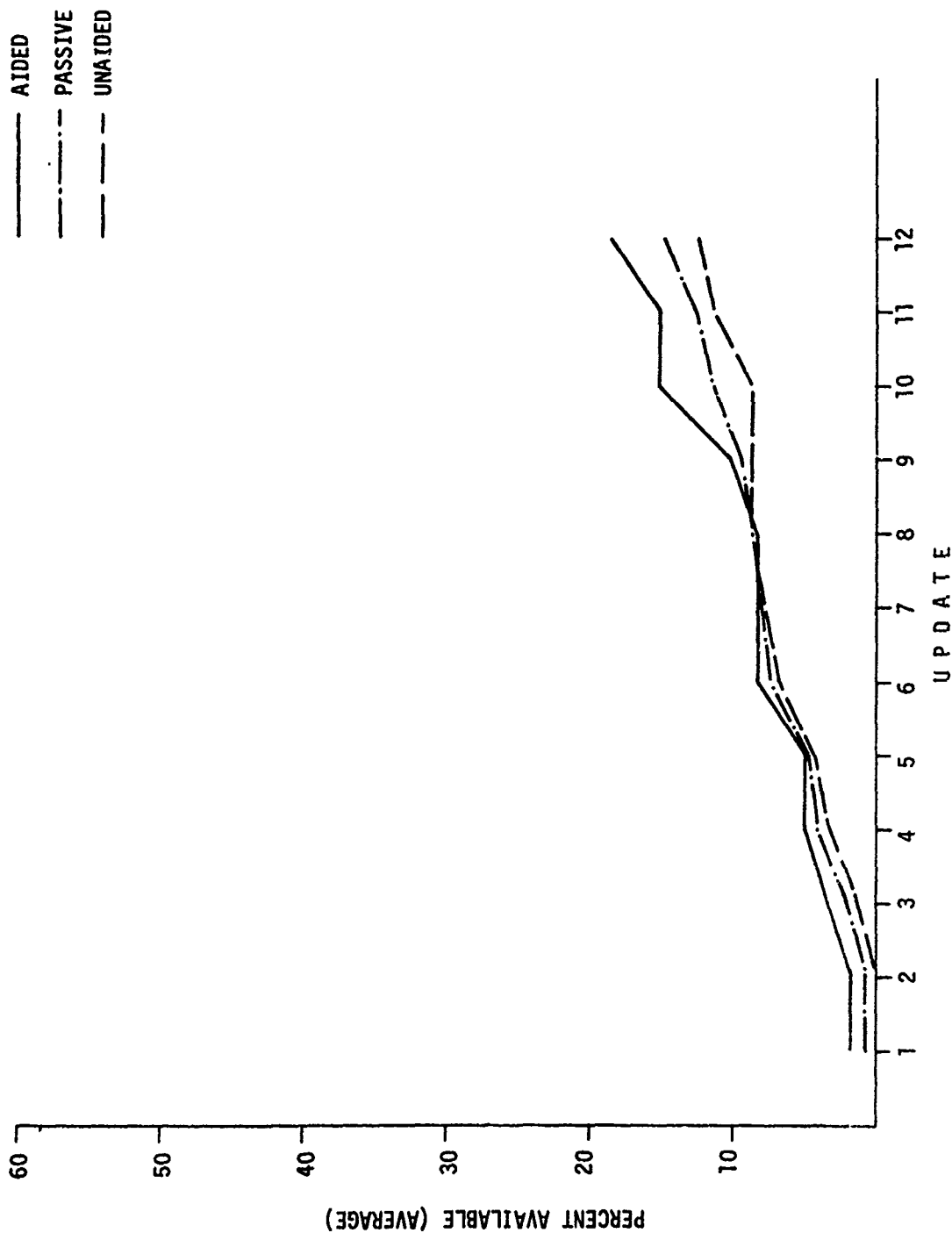U P D A T E
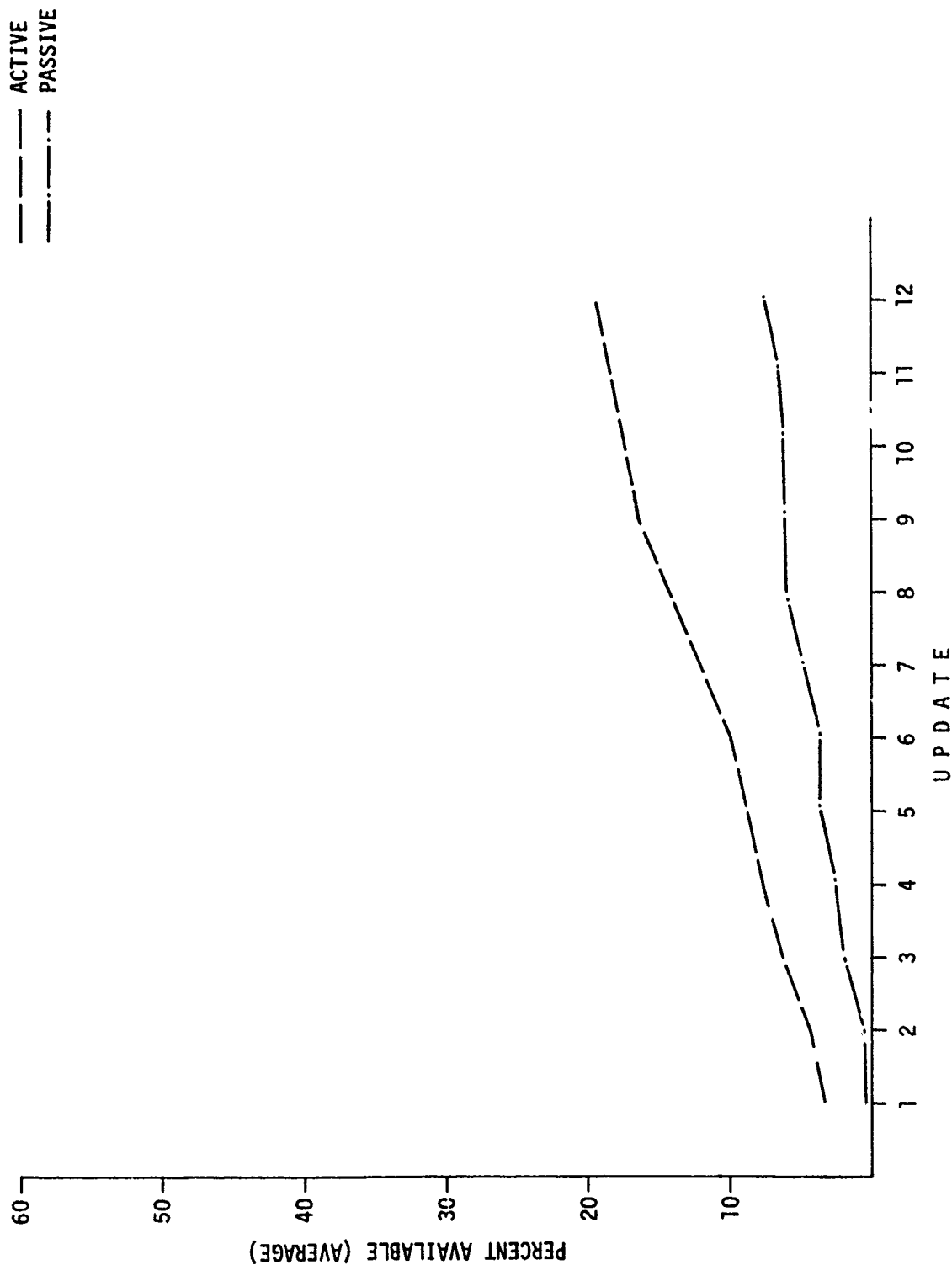
Figure B-102. Weapon Expenditure - HJ: Active/Passive
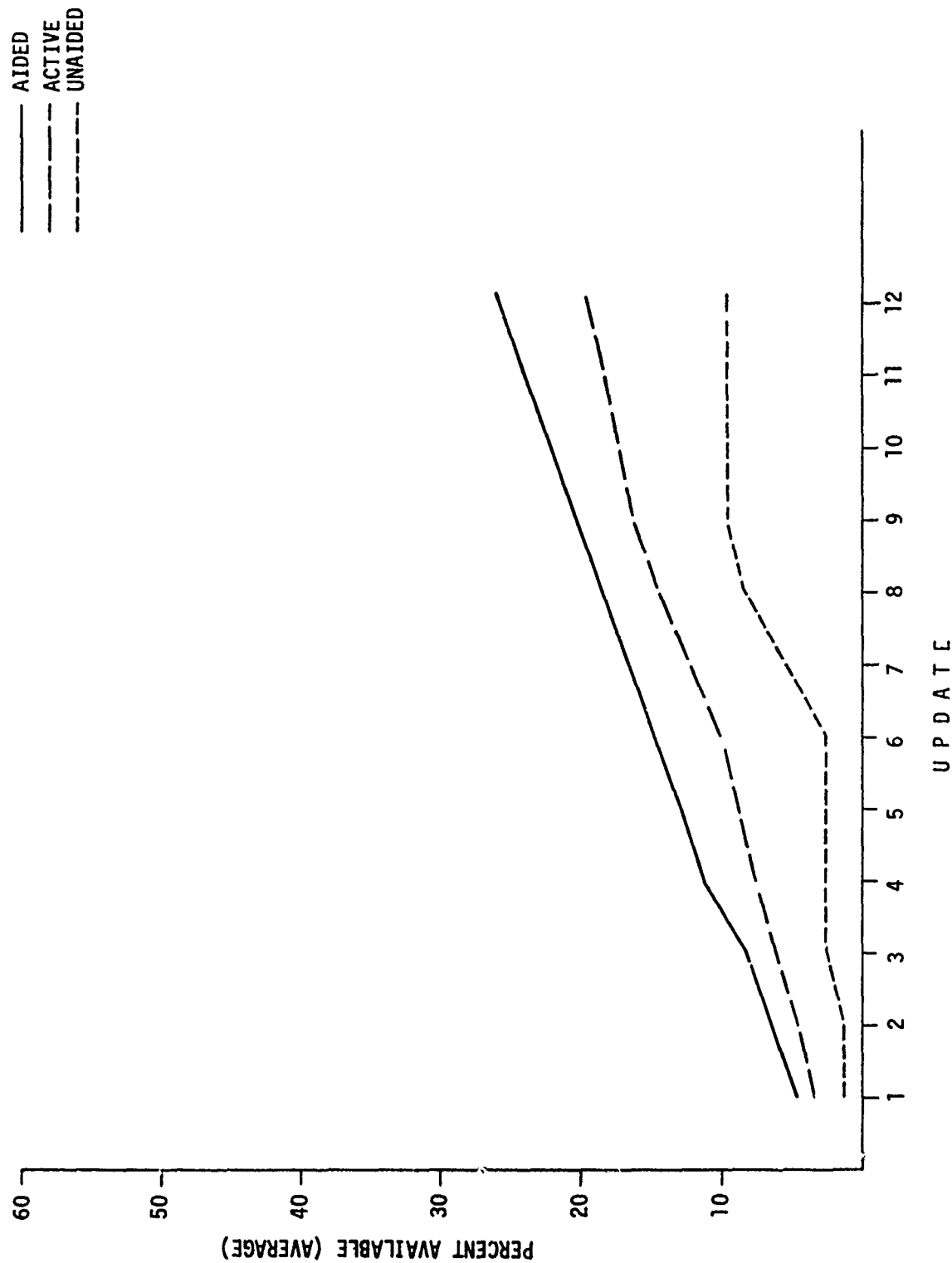
Figure B-103. Weapon Expenditure – HJ: Active (Aided and Unaided)

Figure B-104. Weapon Expenditure - HJ: Passive (Aided and Unaided)
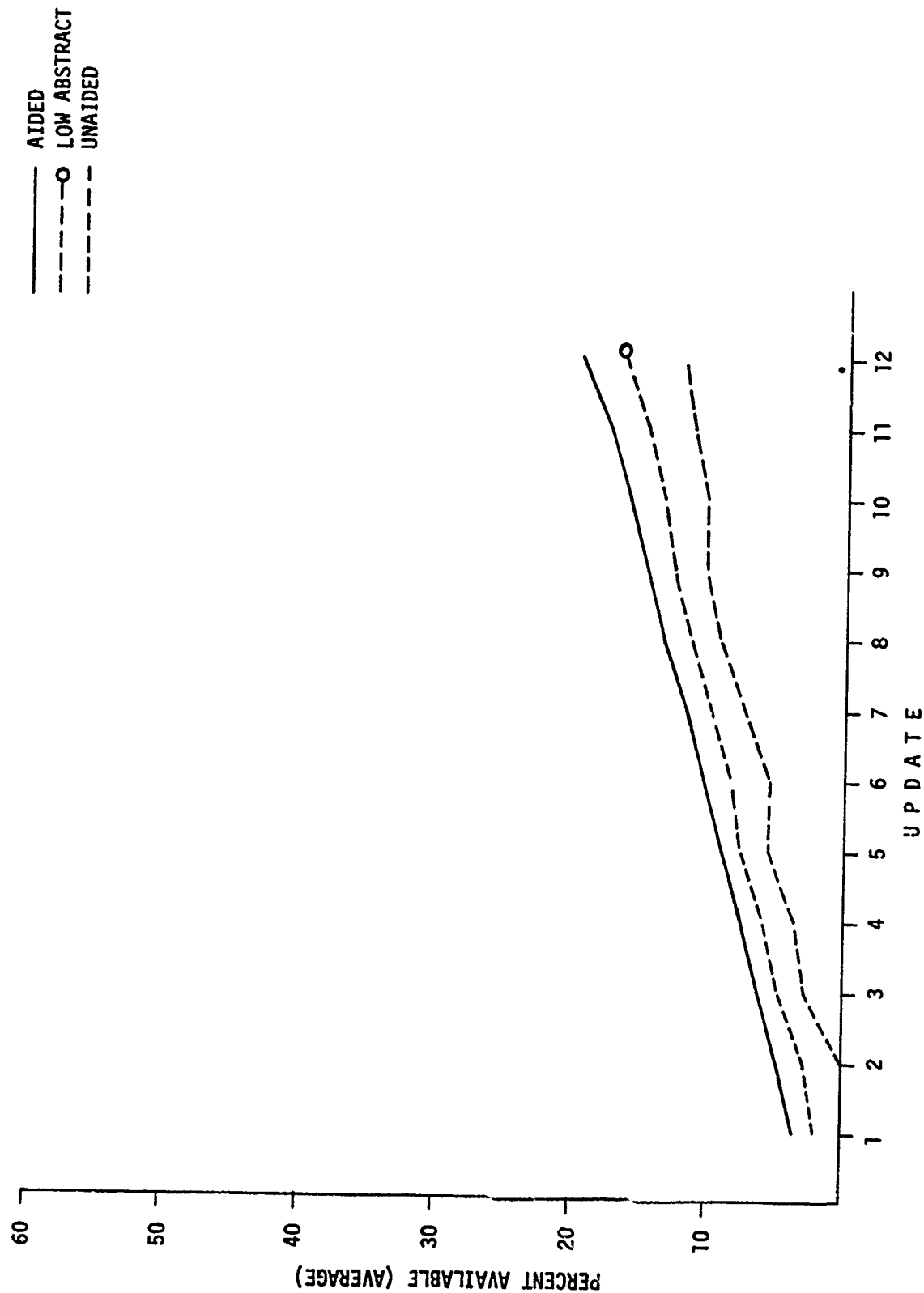
Figure B-105. Weapon Expenditure – HJ: Low Abstract (Aided and Unaided)

Figure B-106. Weapon Expenditure – HJ: High Abstract/Low Abstract/Concrete

LOW ABSTRACT
HIGH ABSTRACT
CONCRETE

UPDATE

PERCENT AVAILABLE (AVERAGE)

60

50

40

30

20

10

1 2 3 4 5 6 7 8 9 10 11 12

INTUITIVE

LOGICAL

60

50

40

30

20

10

PERCENT AVAILABLE (AVERAGE)

1 2 3 4 5 6 7 8 9 10 11 12

U P D A T E

Figure B-107. Weapon Expenditure - Tac Air: Logical/Intuitive

PERCENT AVAILABLE (AVERAGE)

UPDATE

UNAIDED
LOGICAL
AIDED

Figure B-108. Weapon Expenditure - Tac Air: Logical (Aided and Unaided)

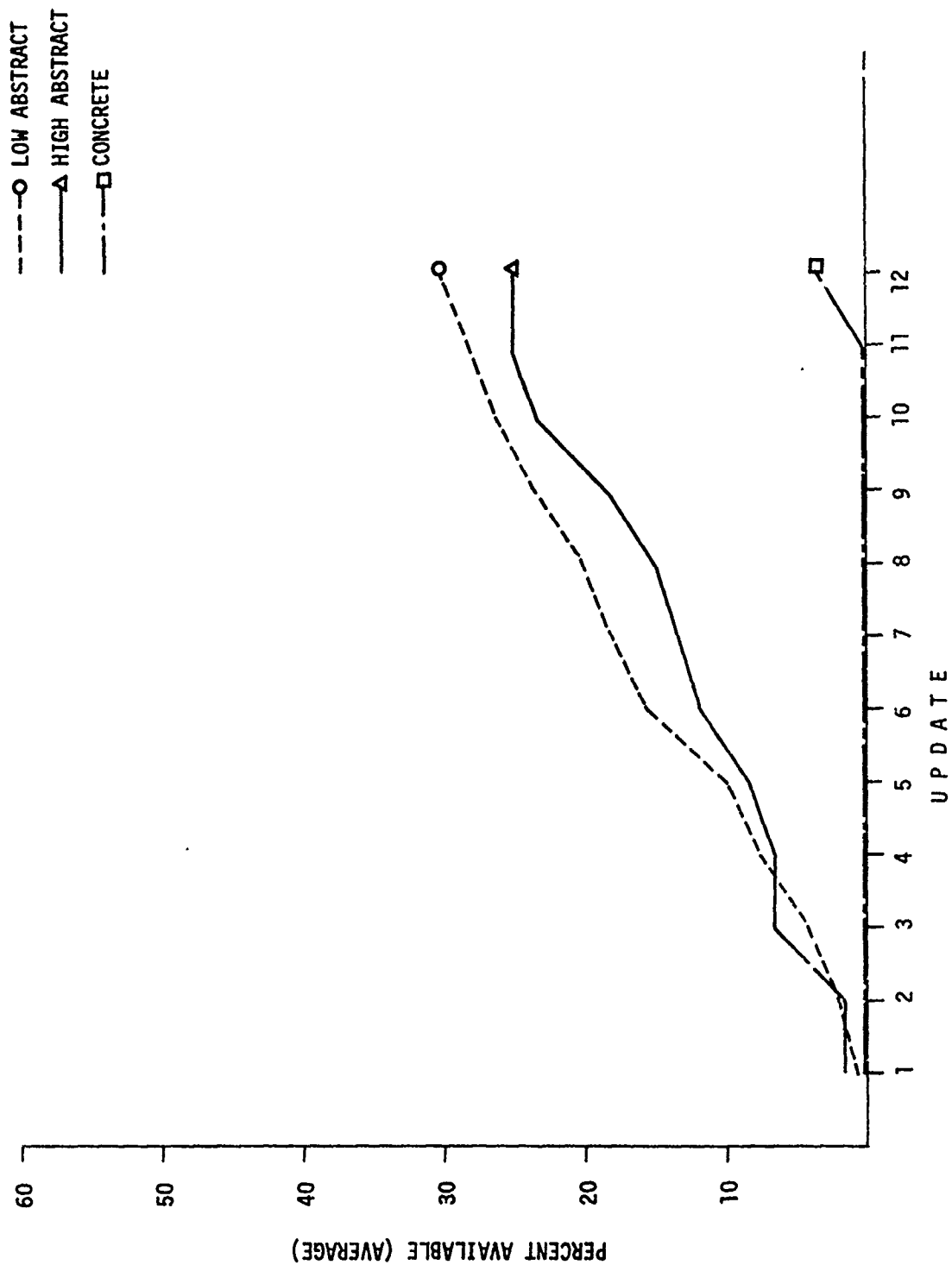Figure B-109. Weapon Expenditure – Tac Air: Intuitive (Aided and Unaided)

Figure B-110. Weapon Expenditure - Tac Air: Active/Passive

Figure B-111. Weapon Expenditure - Tac Air: Active (Aided and Unaided)

Feigure B-112. Weapon Expenditure - Tac Air: Passive (Aided and Unaided)

LOW ABSTRACT
HIGH ABSTRACT
CONCRETE

PERCENT AVAILABLE (AVERAGE)

60

50

40

30

20

10

1 2 3 4 5 6 7 8 9 10 11 12

U P D A T E

Figure B-113. Weapon Expenditure – Tac Air: High Abstract/Low Abstract/Concrete
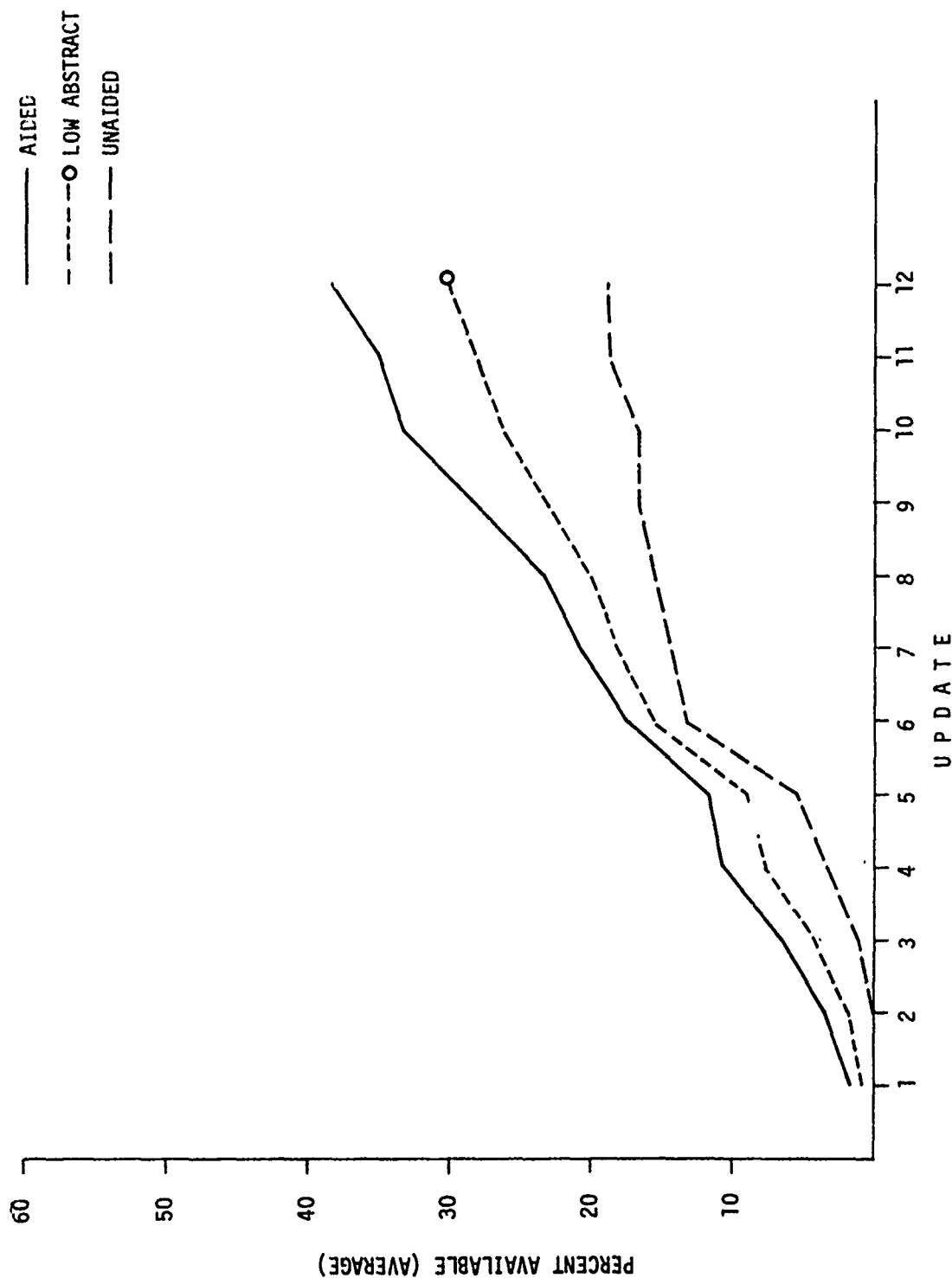
Figure B-114. Weapon Expenditure – Tac Air: Low Abstract (Aided and Unaided)
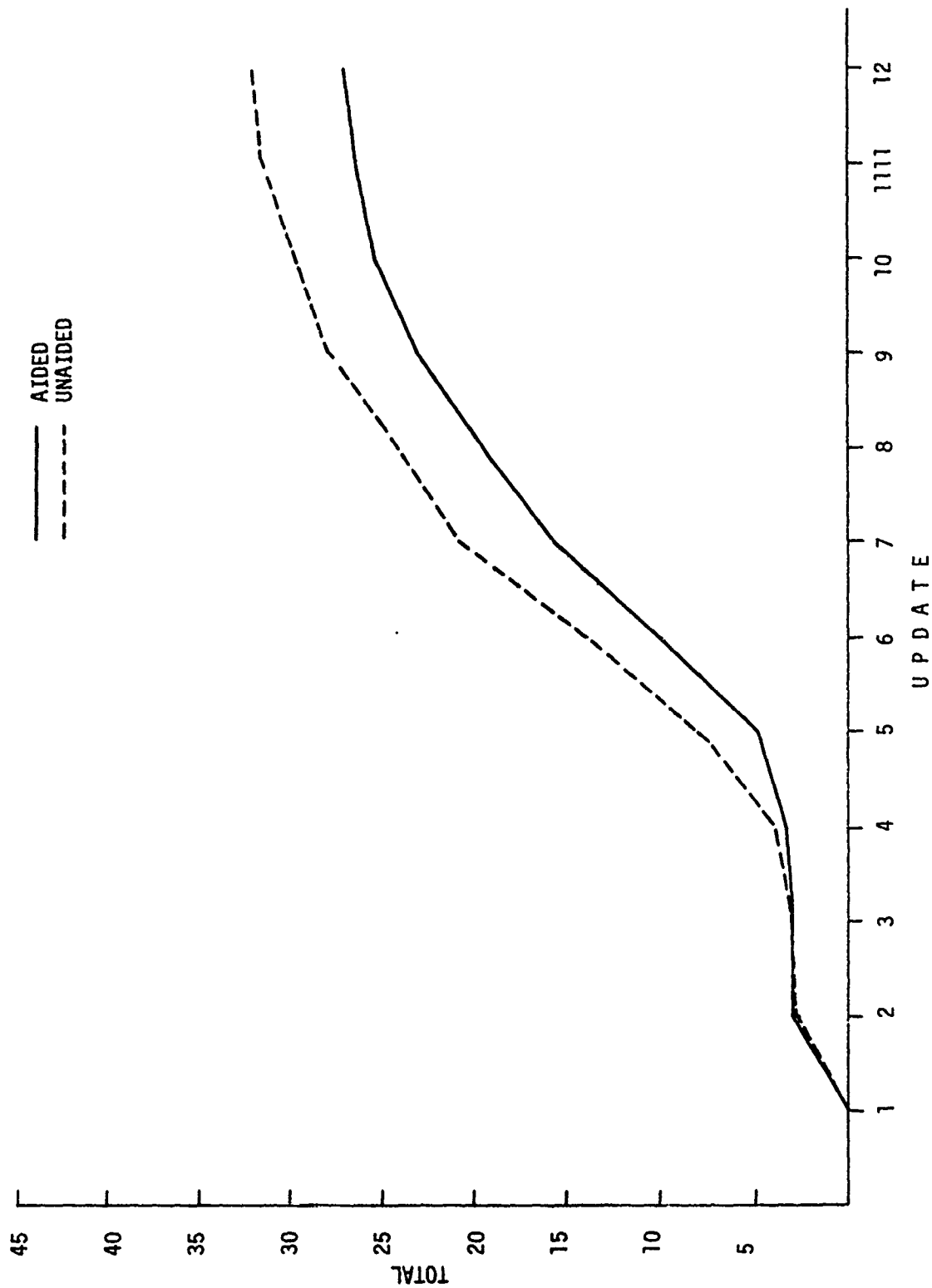
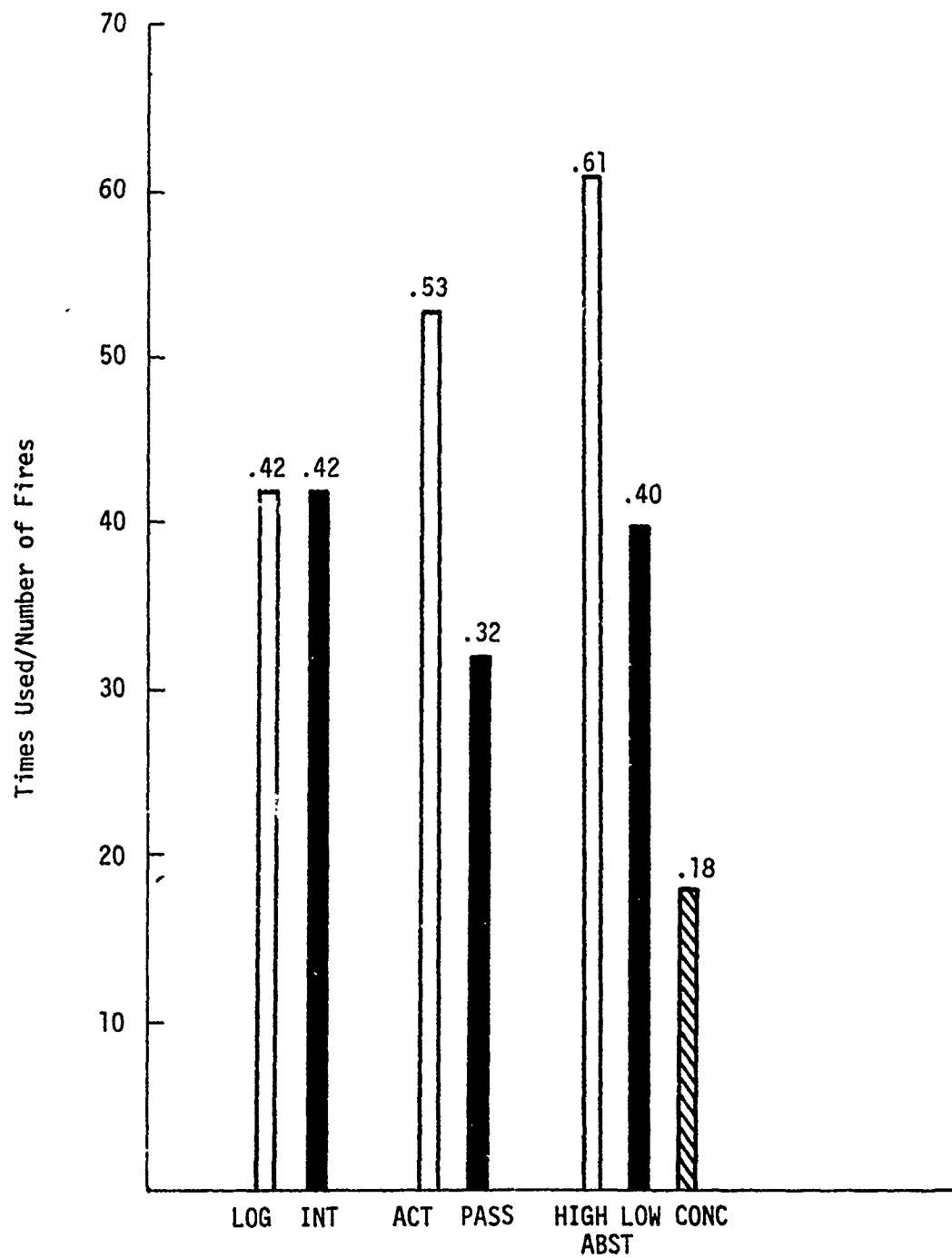Figure B-115. Objectives Reached: Aided/Unaided

Figure B-116.   Resource Allocation – Usage Efficiency: Style Groups
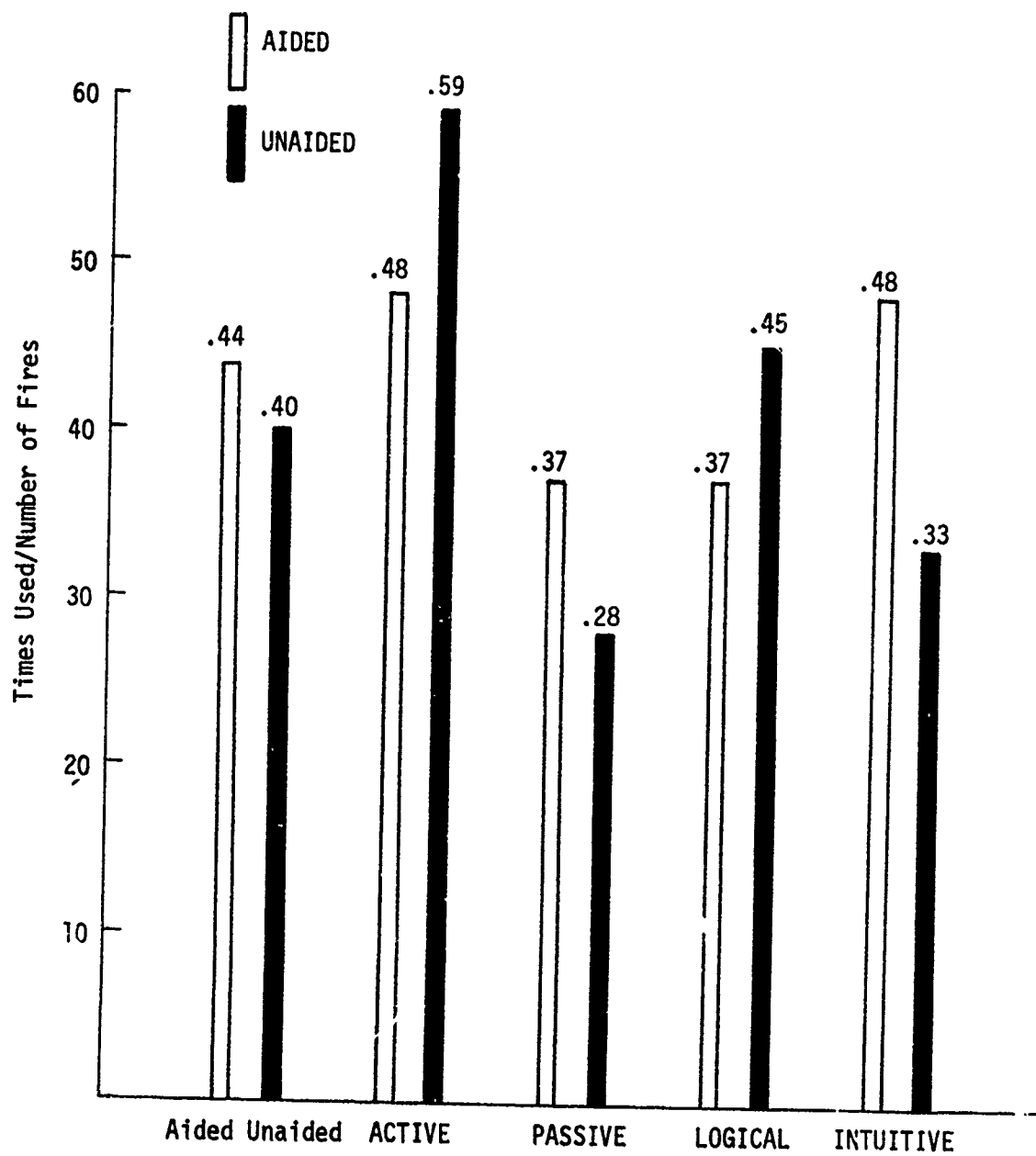
Figure B-117. Resource Allocation – Usage Efficiency: Aided/Unaided
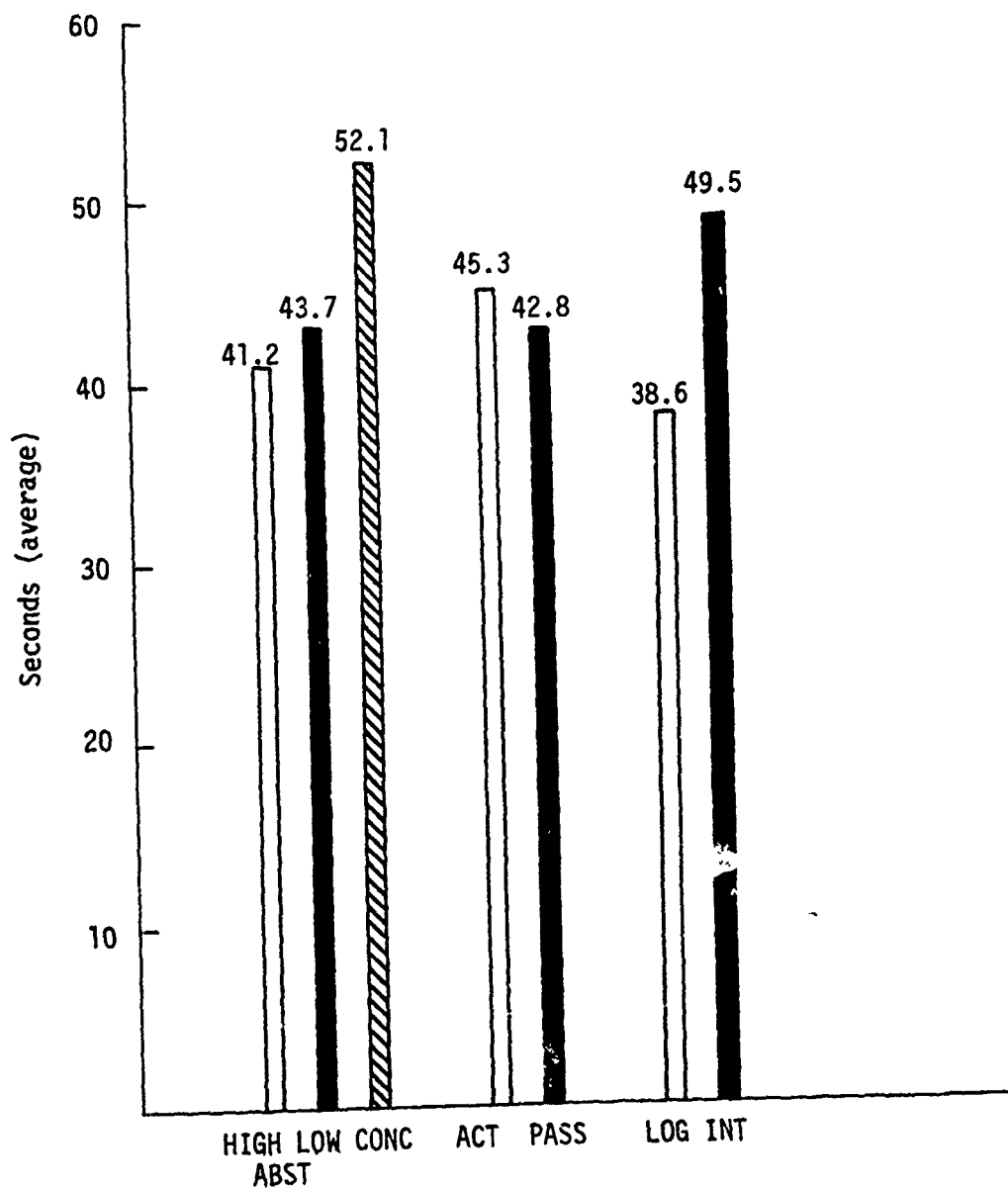and Style Groups (Aided/Unaided)

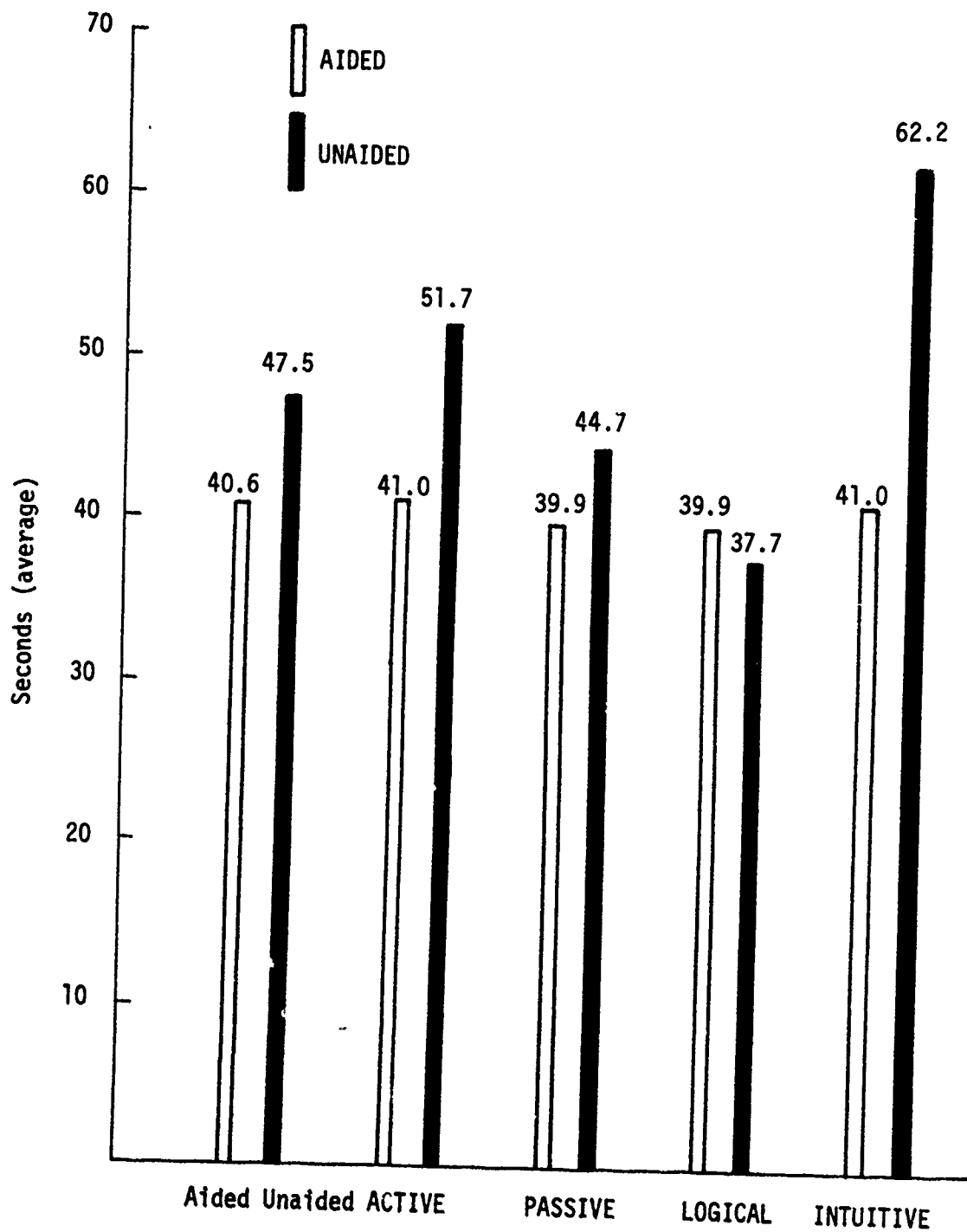Figure B-118. Resource Allocation - Firing Time: Style Groups

Figure B-119. Resource Allocation – Firing Time: Aided/Unaided and Style Groups (Aided/Unaided)

APPENDIX C

MEASURES USED FOR PERFORMANCE ANALYSIS OF PLANNING AND COMBAT DATA

Table C-1. Measures Used for Performance Analysis of Planning and Combat Data

MEASURES	PLANNING	COMBAT
Information Processing		
1. Sources Sought	X	X
2. Action Ratio	X	X
3. Error Ratio	X	X
4. Redundancy Ratio	X	X
5. Information Acquisition Ratio	X	X
6. Resource Allocation Usage Efficiency		X
7. Firing Time		X
Tactical		
1. Defensive Plans	X	X
2. Friendly Force Attrition		X
3. Enemy Force Attrition		X
4. Distance Surrendered		X
5. Friendly Force Weapon Expenditure		X
6. Events		X
7. Enemy Force Objectives Reached		X